

Federal Aviation Administration



Radio Spectrum Plan for 2001-2010

(2004 Revision)



Vice President of Technical Operations
Air Traffic Organization
March 25, 2005

Radio Spectrum Plan

(2004 Revision)

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Technical Operations, ATO-W

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Executive Summary

The 2004 revision of the Radio Spectrum Plan provides an update on very high frequency (VHF) air-ground (A/G) communications, navigation, and surveillance service requirements, looking ahead to the 2010 time period. The VHF A/G communications plan was developed in response to a key recommendation of the next generation VHF A/G communications system (NEXCOM) Aviation Rulemaking Committee (NARC), which recommended that the Federal Aviation Administration (FAA) should aggressively manage frequency assignments to prolong the useful life of the present 25 kHz system and conduct an annual assessment, looking ahead at least 5 years. The VHF A/G communications, navigation, and surveillance services addressed in this report play a critical role in ensuring a safe and efficient air traffic control system in the United States. This spectrum plan is a support element in FAA's Capital Investment Plan (CIP), Flight Plan 2004-2009, and Operational Evolution Plan (OEP).

By the year 2000, it had become difficult to satisfy the increasing VHF Air Traffic Service (ATS) A/G voice communications frequency assignment requirements. Consequently, the FAA undertook a broad, systematic study late that year to ensure that new ATS A/G communications requirements could be satisfied until 2010 by extending the life of the present system. At that time new system elements were expected to be available to satisfy new requirements in the post-2010 time period. The study effort resulted in the identification of 25 improvement measures, which are being pursued within the FAA and through coordination with concerned United States Government and non-Government agencies. The gains obtained from these improvement measures to date are highlighted herein.

Based on available information, we believe that the present VHF A/G communications system will be able to support the efficient operation of the National Airspace System (NAS) until 2010, assuming that much of the estimated gain from the identified improvement measures can be achieved. A growth estimate of approximately 1,230 new frequency assignment requirements may be needed to satisfy the air traffic control system needs until then. Further, with the implementation of air traffic system conditions and restrictions to limit the number of new frequency assignment requirements, it is judged that the present system could continue to serve the NAS until 2015, the new projected date for the implementation of a new system. The spectrum resources available to satisfy future requirements include the potential gain to be obtained from the 25 improvement measures and the significant spectrum resources available in many geographic areas (above and beyond that to be gained from the improvement measures), especially those outside of areas experiencing severe frequency congestion.

In the navigation system area, there is severe frequency congestion in the further implementation of Instrument Landing System (ILS), VHF Omnidirectional-Range (VOR), and Distance Measuring Equipment (DME) installations in the high traffic density areas of the NAS. In particular, it is concluded that some of the expected future

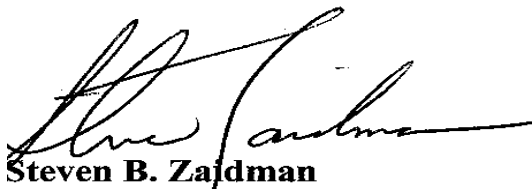
requirements for new ILS installations cannot be satisfied in some high traffic density areas. Coordination will continue within the FAA to address this significant issue, including considering possible alternatives to solve the problem and reaching a timely decision on the action to be taken.

As a result of new studies conducted within RTCA, Incorporated, it was determined that it will be possible to accommodate the new Global Positioning System (GPS) civil signal, L5, without making any frequency changes to DME, Tactical Air Navigation, or VOR facilities (previously a significant number of frequency changes involving these facilities had been anticipated). Other navigation system spectrum congestion problems must be faced, but except as noted above, no insurmountable problems are expected in satisfying other known navigation system requirements until 2010.

In the Surveillance section, air traffic control surveillance and weather radar systems have been highlighted and addressed, focusing on the satisfaction of future spectrum requirements to support these system capabilities until the year 2010. Frequency congestion is a concern in several frequency bands. A multitude of systems are operating in the radar beacon bands (1030/1090 MHz), and new functions are planned to operate there. Action is being taken to help alleviate the present high degree of channel congestion and Mode-S site identification limitations in these band segments.

Frequency congestion is also a problem in the long-range radar band (1215-1390 MHz), where the FAA has dealt with the impacts of the loss of the 1390-1400 MHz band segment, as a result of the Omnibus Budget Reconciliation Act of 1993. While frequency congestion and possible sources of interference are also concerns in a number of other bands, it is concluded that the future spectrum requirements for enroute, terminal, and airport surface surveillance, as well as weather radar requirements, can be satisfied until 2010.

In the next year, the remainder of the 25 VHF A/G communications system improvement measures will continue to be pursued toward implementation. New requirements for communications, navigation, and surveillance systems, as they surface, will continue to be addressed. In addition, this plan will be expanded in future years to include other NAS system elements.



Steven B. Zajdman
Vice President,
Technical Operations Service

VHF Air-Ground Communications

1.1 Introduction

1.1.1 The three necessary functions required to provide a safe and efficient air traffic control service are communications, navigation, and surveillance (CNS). The air-ground (A/G) safety communications element (Air Traffic Service (ATS) communications) is provided in the National Airspace System (NAS) through the use of very high frequency (VHF) spectrum resources within the 118-137 MHz band.

1.1.2 The 118-137 MHz frequency band, using double-sideband amplitude modulation (DSB-AM), has been used for many years to satisfy the ever increasing ATS A/G voice communication requirements in the Continental United States (CONUS). (For clarification, it should be noted that ATS communications, i.e., safety communications, are sometimes informally called air traffic control (ATC) communications, even though the requirements extend beyond ATC usage.) However, while a new system, providing increased communications capacity and data link communications, has been pursued for over ten years, the burden still lies on the present VHF voice system to continue to satisfy the ever increasing requirements until the post-2010 time period (presently projected to be 2015), when a new system can be implemented. The unexpected delay in implementing the new system has caused severe frequency assignment congestion to occur in some areas of the CONUS, requiring the Federal Aviation Administration (FAA) Air Traffic Organization Technical Operations Services (ATO-W) to take drastic action to satisfy expected future requirements.

1.2 Purpose

1.2.1 The purpose of this plan is to provide an overview of the significant planning and actions being taken by ATO-W to gain the additional A/G communications capacity to satisfy new voice communications needs within the NAS until the 2010 time period, and beyond. It was previously estimated that the next generation VHF A/G communications system (NEXCOM) would be implemented and used to satisfy new requirements in the 2010 time period. However, it is presently projected that a new system will not be implemented until 2015.

1.3 Background

1.3.1 The use of the 118-137 MHz band for ATS communications has evolved over many years. The two broad categories of safety communications provided within the band are ATS and aeronautical operational control (AOC). AOC is provided and used by the airlines (and other users) for airline operational communications, flight following, etc.

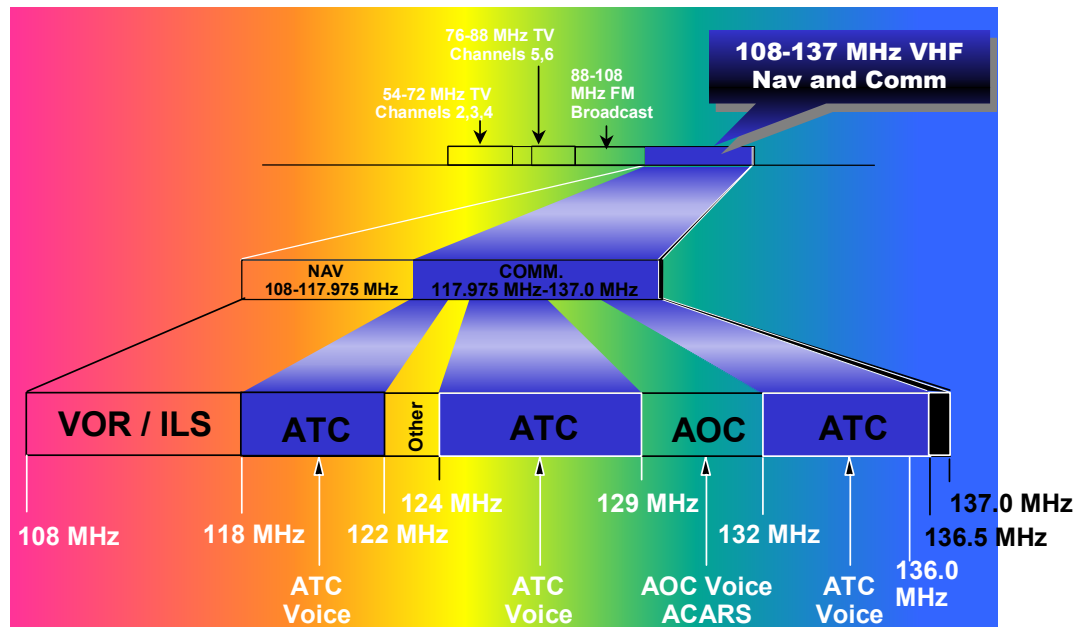
A more detailed background discussion on this and other aspects is presented in Appendix 1.1.

1.3.2 The channel capacity of the VHF band has increased significantly over the years through the implementation of channel splitting, the last, to 25 kHz, occurring in 1977. When the decision was made in the late 1970's not to implement satellite-based A/G communications in the VHF band, the band segment 136-137 MHz was also added to the band (of which 136-136.475 MHz is available for ATS usage). However, the expansion of available channel capacity has been slow. In 1992, the FAA issued an advisory circular to voice the requirement for 25 kHz radios. However, there are still many general aviation aircraft equipped with 50 kHz radios, resulting in a desire to have non-25 kHz channel frequency assignments for many operations. In addition, many aircraft are not equipped to make use of the added band segment, 136-137 MHz.

1.3.3 Figure 1.1 provides a pictorial view of how the 118-137 MHz band is split up within the United States, showing that of the 760 (25 kHz) channels available in the band, only 524 are available for ATS. The remainder is used for AOC, general aviation, flight testing, etc. In addition, some of the 535 channels are used to coordinate fire fighting, used to support air shows, dedicated Department of Defense (DOD) channels, etc. However, it should be noted that two ATS channels above 136.0 MHz have been assigned nationally until 2011 for A/G data services under the Flight Information Service – Data Link (FISDL) program.

Figure 1.1 Limited VHF Resource to Meet Requirements

Total Channels Available = 760 ATS Channels = 535

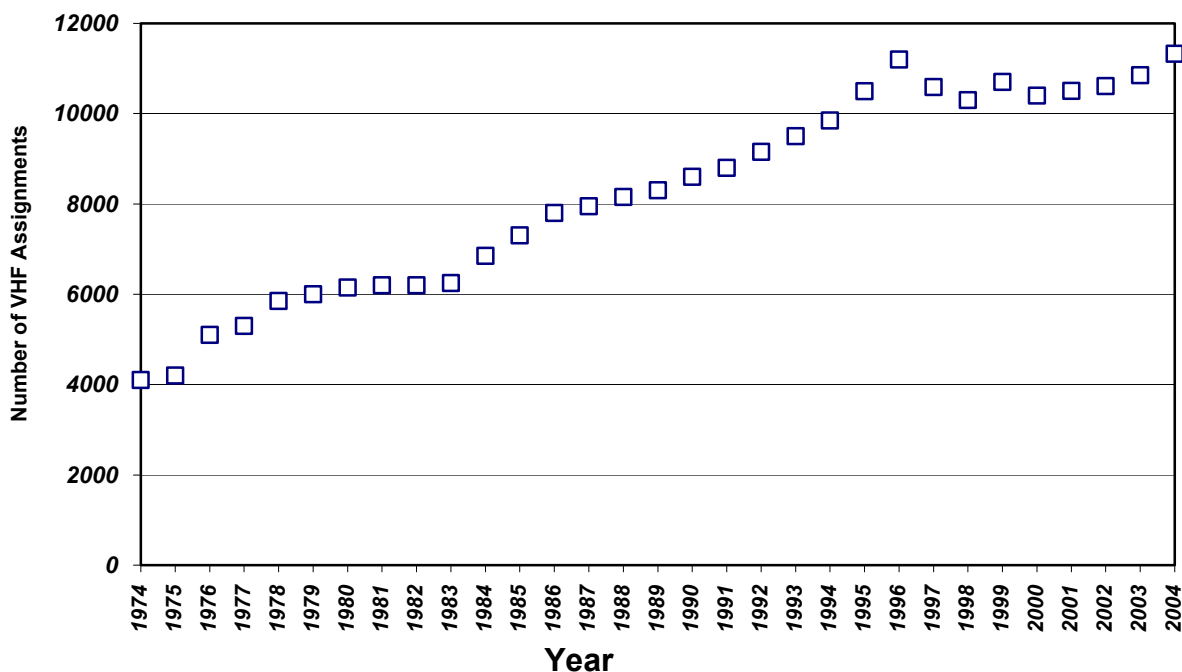


1.4 Future VHF ATS A/G Frequency Requirements

1.4.1 The growth of VHF ATS frequency assignments, in response to ever-increasing requirements, has been quite linear over the past 25 years. [Figure 1.2](#) shows that the average increase has been about 241 frequency assignments a year since the early seventies.

Figure 1.2

Growth of VHF Spectrum Usage



Average Growth Per Year = 241 Assignments

1.4.2 In order to more carefully examine the recent growth of frequency assignments, a new analysis was conducted in 2003, and updated in 2004, which reviewed the growth of new frequency assignments (requiring a new protected service volume) over each of the past seven years (from September 1997 through September 2004). In this analysis the total growth has been broken down into the three main categories: terminal, enroute, and broadcast. The results of this analysis are presented in [Table 1.1](#). It should be noted that the average growth of approximately 117 frequency assignments per year is significantly lower than the growth of approximately 241 assignments per year shown in [Figure 1.2](#). A number of factors help to explain this apparent discrepancy, as presented in Section 1.4.3 below.

Table 1.1
Seven-Year Growth of
New VHF A/G Frequency Requirements

	7-Yr Growth	7-Yr Grwth %	Avg Growth/Yr	Avg Grwth/Yr %
Total Terminal	132	2.59%	19	0.37%
Total Enroute	76	4.86%	11	0.69%
Total Broadcast	614	51.47%	88	7.35%
Total	822	10.47%	117	1.50%

1.4.3 First, as shown in [Figure 1.2](#), the long term average growth of frequency assignments is subject to variations. In particular, a sizable number of frequency assignments were recovered in the latter 1990s as a result of frequency audits (the results of which are reflected in [Figure 1.2](#)). Another frequency audit conducted by FAA air traffic organizations (Air Traffic Organization Enroute and Oceanic Services (ATO-E) and Air Traffic Organization Terminal Services (ATO-T)) resulted in the recovery of a significant number of frequency assignments during fiscal year (FY) 2002 (see Improvement Measure 11 later in this report). In addition, the FAA has to date been able to recover some assignments from DOD “database clean-ups”. Finally, as a result of the September 11, 2001, tragedy, and the resulting change of focus of the FAA and the airlines, very few new frequency assignments were made during the following year, and this trend extended into 2003.

1.4.4 It must be recognized that it is not possible to exactly predict such characteristics as the number and service volumes (i.e., coverage requirements) of the new VHF A/G ATS communication requirements that will surface up to the 2010 time period. However, taking into account the new air traffic control system changes (see Section 1.4.5), and the anticipated growth of air traffic in the future (see [Ref. 1.1](#)), it is expected that the future growth of frequency assignments will be significantly greater than that reflected by the past seven year average. FAA and contract tower operations, and enroute center operations, are forecast to increase at an average rate of approximately 2 percent per year, and over 2 percent per year, respectively, over the time period until 2014 ([Ref. 1.1](#)).

1.4.5 This VHF plan is a support element in FAA's Capital Investment Plan (CIP), Flight Plan 2004-2009, and Operational Evolution Plan (OEP), which address a number of new and pending air traffic control system changes that will require additional A/G communications resources. The changes include:

- 1) implementation of "Choke Points" sectors ,

- 2) implementation of airspace redesign of the NAS...requiring the assignment of new sectors,
- 3) implementation of reduced vertical separation minimum (RVSM)...requiring frequencies to be assigned for the new sectors, and
- 4) the expansion of non-movement areas at major airports, thus increasing the need for frequencies.

1.5 Overview of Action Being Taken to Satisfy VHF Requirements to 2010

1.5.1 The focus of this plan is to satisfy VHF A/G ATS voice requirements to the 2010 time period. (However, as highlighted in Section 1.6.11 below, a 2003 ATO-W ATC Spectrum Engineering Services spectrum depletion analysis study was conducted to consider the satisfaction of requirements until 2015 using the present system.) While data link communications has been used for AOC for some years, it is presently being used for only non-time critical ATS communications. These data link services, as well as non-time critical controller-pilot data link communications (CPDLC), will continue to be provided from spectrum resources within the AOC allotment in the 118-137 MHz band by a service provider. ATS voice communication requirements continue to increase, because, in large part, it is the A/G communications element used for time-critical ATS communications.

1.5.2 Previous system improvements, which were concentrated on increasing efficiency, were quite effective over the time period that they were expected to be needed to help satisfy new requirements. However, when the initial operation of the NEXCOM was delayed to the 2010 time frame, additional measures were needed to help ensure that new communication requirements could be satisfied until that time period. These measures were focused upon increasing the number, and utilization efficiency, of the channels available for ATS communications. In late 2000, ATO-W ATC Spectrum Engineering Services began a systematic study to identify what actions might be taken to extend the life of the present system up to 2010. Unlike previous activities, significantly more aggressive actions needed to be considered. Included in these measures, for example, is the proposed use of 136-136.475 MHz, which had previously been identified for the initial implementation of the NEXCOM. Such luxuries were no longer possible, since every possible spectrum resource needed to be marked for near term use.

1.5.3 As a result of a study (completed in calendar year (CY) 2001) performed within ATO-W ATC Spectrum Engineering Services, and through coordination with and participation from the FAA Frequency Management Officers (FMOs) and the FAA William J. Hughes Technical Center, 23 possible improvement measures were identified (later, two additional measures were identified, for a total of 25; hereafter these are referred to as the 25 improvement measures). Descriptions, expected benefits, and recommendations for each of these measures were developed.

1.6 System Improvements Being Pursued and the Satisfaction of Requirements

1.6.1 The 25 improvement measures identified to be pursued involved a variety of technical, regulatory, and administrative changes. Many of these measures required coordination with other government agencies, in particular the Federal Communications Commission (FCC) and the National Telecommunications and Information Administration (NTIA), and the user community (in particular, the general aviation community and the Aircraft Owners and Pilots Association (AOPA), which represents this community). In addition, significant international coordination would be necessary to implement a number of the improvement measures. Coordination with Canada and Mexico would be needed, as well as coordination with the International Civil Aviation Organization (ICAO) and the International Telecommunication Union (ITU). Some of these measures required financial and technical resources to support such activities as system testing and computer software changes.

1.6.2 The candidate improvement measures would, if successfully implemented, result in a variety of spectrum management gains. A number would result in directly gaining new frequencies, some never before used for ATS, to be used to make new assignments. Others would result in improvements in the ability to make frequency assignments, through, for example, changes in the frequency assignment criteria.

1.6.3 It should be noted that there was no guarantee that all of these measures could be implemented, since they depended in large part on gaining agreement from other entities or on the results of testing. Many of these measures were quite costly and drastic in scope.

1.6.4 Further, the exact degree of improvement resulting from the totality of these measures could not be precisely quantified. If additional improvement from the present system was needed in future years, beyond those gained with the identified actions, more drastic action might be pursued. Examples of such action include separating the transmitter and receiver sites to improve co-site performance, and denying or restricting enroute and terminal requirements; however, such actions could result in significant costs to procure new land and build new facilities, or significantly impacting the efficient movement of air traffic, respectively.

1.6.5 The 25 improvement measures being pursued are identified below. These are identified as being short term, medium term, or long term, depending on whether they are anticipated to be implemented by the year 2004, 2007, or 2010 and beyond, respectively. Table 1.2 provides a summary of the estimated improvement to be gained from each measure. A detailed plan for each of these measures has been developed and is being used by ATO-W ATC Spectrum Engineering Services to coordinate and track each measure. Appendix 1.2 contains additional information on these improvement measures, including the entities to be involved in the coordination and work to achieve the objective, an estimate of the schedule for completion of each measure, and a summary of the FY-2004 improvements gained from the measures (see Table A1.2-1). This appendix

Section 1 - continued

also provides an explanation of the assumptions used to estimate the improvement to be gained from these measures.

- 1) Investigate the use of part of the 121.5 MHz Guard Band for ATS assignments: Medium Term
- 2) Seek alternative channels for the current two flight check frequencies: Medium Term
- 3) Investigate/review the current use of law enforcement channels and identify alternative frequencies for their use, e.g., ultra high frequency (UHF)/Land Mobile: Medium Term
- 4) Review the FCC frequency use plan, including investigating the use of Aeronautical Advisory Station (UNICOM) and other FCC aeronautical frequencies for ATS: Long Term
- 5) Investigate the possibility of using Flight Service Station (FSS) channels for ATS, including the frequencies 123.6 MHz through 123.65 MHz: Medium Term
- 6) Investigate the use of the band segment 136-137 MHz for ATS: Medium Term
- 7) Review standard service volume guidelines in Order 6050.32: Short Term
- 8) Investigate the use of directional antennas for selected applications: Not being pursued (see Appendix 1.2)
- 9) Review and reassess policy of assigning Automated Weather Observing System (AWOS) and Automated Surface Observing System (ASOS) in sub-band: Short Term
- 10) Review assigning ground control (GC) in sub-band: Medium Term
- 11) Conduct ATS Frequency Audit: Medium Term
- 12) Investigate improved co-site mitigation techniques: Medium Term
- 13) Review air show frequency assignment policy: Short Term
- 14) Review fire-fighting frequency assignment policy: Medium Term
- 15) Review use of VHF frequencies by the military and the use of the military common frequencies 126.2 MHz and 134.1 MHz: Medium Term
- 16) Investigate use of VHF Omni-Directional Range (VOR) frequencies for AWOS and ASOS broadcast function only: Medium Term

- 17) Investigate use of offset carrier operation for high altitude and ground service: Medium Term
- 18) Investigate the use of more select keying and voting systems, including reviewing the ATO-E policy on simulcast transmissions: Medium Term
- 19) Investigate lowering GC transmitter antenna height and power output, if possible and practical, provided necessary coverage is maintained: Medium Term
- 20) Investigate the advantages resulting from the optimization of the ground equipment geographical location with respect to the service volume: Medium Term
- 21) Modify the Automated Frequency Manager (AFM) database to accept additional data and modify the frequency assignment model to work with these new data: Medium Term
- 22) Improve coordination with Aeronautical Radio, Incorporated (ARINC) and obtain a more accurate database from them: Medium Term
- 23) Revise the air/ground model to accommodate a 0.6 nautical mile vertical separation: Short Term
- 24) Combine Hazardous In-flight Weather Advisory Service (HIWAS) and ASOS/AWOS service on VOR channels: Not being pursued (see Appendix 1.2)
- 25) Modify the air/ground model to give results by distance ratio instead of frequency order: Short Term

Table 1.2
Estimated Spectrum Use Improvement from the 25 Measures

Improvement Measure	Enroute: Gain - # of Assignments	Terminal: Gain - # of Assignments	Broadcast: Gain - # of Assignments	Gain: # of Assign. per Measure
1) 121.5 MHz Guard Band	0	0	100	100
2) Flight Check Frequencies	10	(78)*	(244)*	10
3) Law Enforcement Chs.	10	(78)*	(244)*	10
4) Review of FCC Use Plan	10	0	0	10
5) Use of FSS Chs.	90	(702)*	(2196)*	90
6) Use of 136-137 MHz. Segment	65	0	0	65

Table 1.2 Continued

Improvement Measure	Enroute: Gain- # of Assignments	Terminal: Gain- # of Assignments	Broadcast: Gain- # of Assignments	Gain: # of Assign. per Measure
7) Review std. Service volume	0	50	0	50
8) Use of directional antenna	0	0	0	0
9) Review AWOS & ASOS sub-band	0	50	0	50
10) Review gnd. Control sub-band	0	25	0	25
11) Conduct ATS freq. Audit	30	70	0	100
12) Improve co-site mitigation	(30) ⁺	(70) ⁺	0	0
13) Review air show assign.	0	10	0	10
14) Review fire-fighting assign.	0	75	0	75
15) Review DOD use 126.2 & 134.1	5	12	0	17
16) VOR use for AWOS & ASOS	0	0	1342	1342
17) Use of offset carrier operation	45	0	0	45
18) Increase select key and voting sys.	38	0	0	38
19) Lower gnd. ctl. tx pwr./ant. height	0	10	0	10
20) Optimization of site location	10	0	0	10
21) Mod. AFM to accept add. Data	0	10	0	10
22) Improve coord. With ARINC	0	10	0	10
23) Accommodate 0.6 NMi vert. sep.	23	20	0	43
24) HIWAS/ASOS /AWOS on VOR	0	0	0	0
25) A/G model ch. for distance ratio	0	0	0	0
Total Gain: Num. of Assign/Use	336	342	1442	Total Gain: 2120 Assign.

Notes: * These numbers indicate that the improvement measure could also provide this many frequency assignments for the indicated function; however, the values are mutually exclusive. For example, a frequency assumed to be used to make enroute assignments could not then also be used for another function (i.e., terminal or broadcast).

+These numbers indicate that a decision to credit these benefits for this improvement measure has not been made, since the exact co-site improvement measures have not yet been decided. However, for this improvement measure, benefits are expected for both the enroute and terminal areas.

1.6.6 The VHF improvement measure initiatives being pursued as part of this plan are already having an impact on frequency assignment congestion. As an example of the benefits being derived from these measures, the National Airspace Redesign (NAR) and the Domestic Reduced Vertical Separation Minima (DRVSM) could not have been achieved without the benefits derived from Improvement Measures 5 and 23 (see Table A1.2-1 for a summary of benefits to date).

1.6.7 The analysis presented in Table 1.1 (which examined the growth of frequency requirements over the past seven years) reflected a lower growth rate (1.50%) than the average growth rate shown in Figure 1.2 (approximately 3 percent in the early 1990s). As discussed in Sections 1.4.2 and 1.4.3, the lower growth rate over the past seven years was not typical, and the growth rate is expected to increase (see Section 1.4.4).

1.6.8 Thus, as a higher bound for growth, it is assumed that the future growth rate (for new frequency assignments requiring a new protected service volume) could return to the previous rate of approximately 3 percent. This would result in a requirement for the next year of about 234 new frequency assignments (based on raising the average 1.50 percent rate of 117 assignments per year over the past seven years to 3 percent). Extrapolating an assumed growth of 234 new frequency requirements per year until the 2010 time period, from the end of September 2004, would result in a requirement for approximately 1230 new frequency assignments (5.25 years x 234 frequency assignments per year). This growth rate will continue to be tracked each year to determine, apply, and take into account any correction that may be needed.

1.6.9 The resources available to satisfy the future requirements include the gain still to be obtained from the 25 improvement measures, which could be as high as approximately 1755 frequency assignments (i.e., 2,120 frequency assignments (see Table 1.2 above) minus the gains achieved to date (see Table A1.2-1)), assuming a fully successful implementation. The difficulty, however, of achieving these objectives must be recognized (see Sections 1.6.3 and 1.6.4). There are also significant spectrum resources available for satisfying frequency assignment requirements in many geographic areas, especially those outside of areas experiencing severe frequency congestion.

1.6.10 Based on study to date, it is concluded that there will be sufficient spectrum resources available to allow the present VHF system to continue to support the efficient operation of the NAS until the 2010 time period, assuming that much of the estimated gain from the improvement measures can be achieved.

1.6.11 In 2003, ATO-W ATC Spectrum Engineering Services carried out a spectrum depletion analysis study (Ref. 1.2) to determine the potential of the present VHF system to support the NAS until 2015. This ATO-W ATC Spectrum Engineering Services spectrum depletion analysis study highlighted the limitation of the present VHF system to support certain areas of the CONUS without imposing constraints. In particular, the more high-traffic density areas of the Eastern United States are subjected to such frequency assignment congestion that it is now extremely difficult to support new ATS

enroute sector requirements. Further, no frequency resources are available to support certain future terminal requirements in a number of areas.

1.6.12 In summary, however, based on the results of the spectrum depletion analysis study (Ref. 1.2), it was judged that the present system could continue to support the operation of the NAS until 2015 if the improvement measures are implemented, and air traffic system changes are imposed, including: (a) restricting enroute and terminal system requirements which would otherwise require new VHF channels, (b) undertaking optimization of the NAS, on a system wide or congested area basis, and (c) requiring all aircraft flying in Class B airspace to have 760 channel radios.

1.6.13 This plan will be updated yearly, with at least a five year outlook, to ensure the best possible view of future requirements and available spectrum resources to satisfy them. In the next year the continuing work will include tracking the frequency assignment requirements, refining the improvement gains estimated to be derived from the 25 improvement measures, and pursuing the completion of the improvement measures.

1.6.14 This plan is responsive to the critical spectrum resource related Recommendation 1 of the NEXCOM Aviation Rulemaking Committee (NARC) report (Ref. 1.3), which recognizes the importance of having adequate VHF spectrum resources to make needed A/G ATS frequency assignments.

1.7 Transition to the Next Generation System - Basic Principles

1.7.1 It has previously been projected that the NEXCOM would begin to be implemented by the 2010 time period. However, the implementation of NEXCOM has been put on hold, pending a joint FAA/Eurocontrol "future communications" system study. The results of this study are pending. However, it is now projected that a new VHF A/G system will not be implemented until the 2015 time period. Pending future decisions regarding the implementation of a new system, the following system transition scenario, based on past planning, is presented to highlight the transition process.

1.7.2 As the year 2010 approaches, plans to implement the NEXCOM, based on the use of four-circuit per 25 kHz time division multiple access (TDMA) technology to provide voice and data link (known as VHF digital link (VDL) Mode 3 (VDL-3)), may be pursued. The early implementation of the NEXCOM would concentrate on voice communications. (It should be noted, however, that the NEXCOM is designed to provide voice and data link communications to an aircraft in a functionally simultaneous manner on the same 25 kHz channel, using a single antenna and radio.) The transition would need to be carried out in a phased approach, taking into consideration the equipage of the airspace users and the types of sectors to be implemented first. Initial demonstration and validation testing must be completed prior to any operational implementation of the NEXCOM.

1.7.3 It would be anticipated that commercial aircraft, and other aircraft that fly in the upper airspace, would be the first class of aircraft to be equipped with the future system. Clearly there would not be sufficient spectrum available to provide access to both the present DSB-AM system and the VDL-3 system, even in the early operational implementation. Thus, all users in a sector implemented to operate on VDL-3 would need to have a radio equipped to operate with the new system capability. However, the user's flight into an upper airspace sector implemented with VDL-3 capability should be functionally transparent to the pilot and controller (except for the new channel "numbering" included for the new system).

1.7.4 A more detailed discussion of the basic principles and issues of transition to the NEXCOM system is provided in Appendix 1.3. This appendix also includes a brief discussion of the possibility of another option to that of VDL-3, a channel split to 8.33 kHz for gaining additional VHF A/G voice capacity, and the use of VDL Mode 2 (VDL-2) for VHF A/G data link. As recommended by the NARC, future planning is also being carried out on the development of an alternative transition plan to take into account the possibility of a transition in the NAS to 8.33 kHz channels for voice and the implementation of VHF A/G data link through the use of industry supplied VDL-2 data link. As highlighted in Section 1.7.1, some segments of the international community are also informally discussing the possible potential of other system designs that might be pursued further as alternatives for future implementation.

1.8 Summary and Conclusions

1.8.1 It is becoming increasingly difficult in many areas of the NAS to find the spectrum resources necessary to make frequency assignments to support new VHF A/G ATS communications requirements. In light of the delay to the 2015 time period for an initial implementation of a new VHF A/G communications system, FAA has foreseen the need to take drastic action to obtain spectrum resources to support new VHF A/G ATS communications requirements until then. ATO-E, ATO-T, ATO-W, and other concerned entities have identified and studied 25 improvement measures. These measures, most of which are seen as being drastic in scope, are being pursued toward implementation. The objectives of many of these measures can only be gained by obtaining the agreement of other Government and civil aviation entities, and coordination with neighboring countries and international organizations. Some of these measures require testing and validation.

1.8.2 The ultimate benefit of these improvements cannot be stated in an exact quantitative manner, since this depends on specific information such as coverage requirements and the number of future frequency assignments that need to be satisfied. However, as highlighted in this report in Sections 1.6.7, 1.6.8, and 1.6.9, these improvement measures, if successfully implemented and used in conjunction with present spectrum resources, are expected to be capable of supporting the efficient operation of the NAS until the 2010 time period. If needed, more drastic improvement measures could be taken, beyond those being pursued; however, such measures would require significant amounts of financial resources (e.g., to purchase land and construct buildings). In

addition, as highlighted in Section 1.6.12, it is judged that the present system could continue to serve the NAS until 2015, assuming that air traffic system conditions and restrictions were implemented to limit the number of new frequency assignment requirements.

1.8.3 This plan will be updated yearly, with at least a five year outlook, so that any unforeseen changes in requirements and/or spectrum resources can be taken into account. This plan is a support element in FAA's CIP, Flight Plan 2004-2009, and OEP, and it is also responsive to Recommendation 1 of the NARC report, which highlights the critical nature of VHF spectrum resource availability and the need to examine such availability on a yearly basis.

Appendix 1.1 To Section 1 – Background Discussion

1. 118-137 MHz Band usage

1.1 The use of the 118-137 MHz VHF band for A/G safety communications has evolved over many years. The band is allocated on a worldwide basis to the Aeronautical Mobile (Route) Service (AM(R)S) by the ITU. AM(R)S is a frequency allocation reserved to be used for safety and regularity of flight, that is safety communications. The two broad categories of communications provided within the AM(R)S are ATS and AOC. ATS broadly supports air traffic control, while AOC is provided and used by the airlines (and other users). AOC is used to satisfy federal air regulations requiring the airlines, in particular, to know where their aircraft are at all times (independently of air traffic control services), the condition of their aircraft (fuel remaining, etc.), and other company-specific information related to safety of flight.

2. Historical expansion of the capacity of the 118-137 MHz band

2.1 The capacity of the VHF band has increased significantly over the years through the implementation of channel splitting and incremental additions to the available spectrum resource. Each of these capacity improvements has required that users purchase new radios to receive the benefits of the additional channels. In 1966, a reduction in channel bandwidth from 100 kHz to 50 kHz doubled the number of channels available. The last channel split in 1977 from 50 kHz to 25 kHz again doubled the number of channels available in the band. In the late 1970's, the band segment 136-137 MHz was added to the VHF band as a result of a spectrum reallocation decision (resulting from a decision not to use VHF for satellite-based A/G communications). However, as a result of a domestic allotment decision, only 136-136.475 MHz is available for ATS usage.

3. Impact of the long life of aircraft radios

3.1 Because of the long life of aircraft radios and the regulatory framework that has allowed 50 kHz radios to be sold until recently (until 1997), many years are needed for general aviation, in particular, to transition to the use of 25 kHz channels. With increasing pressures to gain additional channel capacity, FAA issued Advisory Circular 90-50D in 1992, stating the "Requirements for 760-Channel VHF Radio for Aeronautical Operations". However, there is still a strong general aviation desire to use 50 kHz or 100 kHz channel frequency assignments for some operations. It should be noted that present regulations allow 720 channel radios (i.e., radios not capable of operating in the 136-137 MHz band segment) to be purchased and operated.

4. Allocation of 118-137 MHz band within each country

4.1 Within the ITU 118-137 MHz frequency allocation, each country has the flexibility to domestically allocate/allot the frequency band to specific services to satisfy the A/G communication requirements within its boundaries. Thus, in the United States (U.S.) only 524 channels, of the total of 760 channels available in the band, are available for ATS. The remainder is used for AOC, general aviation, flight-testing, etc. In addition, some of the 524 channels available for ATS are used to coordinate fire fighting, by other federal agencies (Justice, the DOD, etc.), for large air shows (10 assignments for Oshkosh and 5 for Lakeland), etc.

5. Consideration of frequency usage constraints

5.1 A single frequency can be used in more than one location in CONUS. This is called frequency reuse. The degree of frequency reuse depends upon the altitude and service volume (i.e., the required coverage) of the specific service. For example, a frequency that is used for a high altitude sector might only be able to be reused three or four times in CONUS; this limited usage is required to ensure that there will be no radio frequency interference from co-frequency operations. Another factor is that of international borders. ATO-W ATC Spectrum Engineering Services must coordinate with Canada and Mexico to ensure that there is no interference between the frequencies being used; this factor can significantly restrict the use of frequencies in CONUS.

6. Frequency assignment congestion and civil aviation community action

6.1 Frequency assignment congestion using the present 25 kHz channel spacing has been a concern for over 15 years. This subject was addressed at length at the 1990 ICAO Communications/Meteorology/ Operations Divisional Meeting (COM/MET/OPS-1990). Two high traffic density areas of the world (Western Europe and CONUS) were beginning to have difficulty in making new assignments by the 1990 time period. Western Europe pressed for another channel split to 12.5 kHz channel bandwidth. However, as a result of a United States proposal, a recommendation was adopted to carry out a broad system improvement study. Subsequently, the ICAO Aeronautical Communications Panel (ACP) and the then newly initiated RTCA, Incorporated (RTCA), Special Committee 172 (SC-172) both conducted extensive studies on this subject.

6.2 A final report of SC-172, RTCA/DO-225, recommended that a new VHF A/G voice and data link system be developed based upon a 4-circuit per 25 kHz TDMA technology design. This fully digital system would allow any mix of voice and/or data link circuits in any 25 kHz channel (e.g., 4 voice circuits). This design was also adopted by the 1995 ICAO Communications/Operations Divisional Meeting (COM/OPS-1995) as the future VHF A/G communications system. However, the COM/OPS-1995 meeting also agreed upon standards and recommended practices (SARPs) for an 8.33 kHz bandwidth channel split that was to be implemented in the interim to increase voice channel capacity in

Western Europe, which was then experiencing severe frequency assignment congestion. (The relative advantages/disadvantages of these systems have been addressed in other documentation.)

7. System improvements implemented to combat frequency assignment congestion

7.1 In 1995, it was expected that the new system would be in operation by 2004. In order to continue to satisfy the new frequency requirements, a number of system improvements (i.e., improvements to the 25 kHz DSB-AM system) were pursued, including the following:

- 1) restrict the volume of service coverage,
- 2) use a less stringent 14 dB protection ratio for co-channel frequency assignments (coordinated through ICAO...the nominal ICAO protection ratio was 20 dB),
- 3) use of navigational aid voice outlets (on VORs and Non-Directional Beacons (NDBs)) for Automated Terminal Information Systems (ATIS)/AWOS/ASOS.
- 4) increased use of receiver multicouplers and transmitter combiners,
- 5) reduction of ground transmitted power, and
- 6) use of selective keying for large enroute sectors.

7.2 All of these improvements were implemented and have been very effective over the time period that they were expected to be needed to help satisfy new requirements.

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APPENDIX 1.2 TO SECTION 1

DISCUSSION OF THE 25 IMPROVEMENT MEASURES

1. INTRODUCTION

1.1 The purpose of this appendix is to present a brief discussion and information about each improvement measure identified in the body of this report. These measures have either been closed (i.e., dropped from further consideration), implemented, or are being pursued toward implementation. The objective is to gain further improvements in terms of access to additional spectrum to make VHF ATS A/G communications frequency assignments, or to obtain improvements in the use of the spectrum resources available to make these assignments. At the end of this appendix in Section 4, Table A1.2-1 presents a status summary of the 25 improvement measures to date.

2. ESTIMATION OF GAIN TO BE OBTAINED FROM IMPROVEMENT MEASURES

2.1 A related companion study (Ref. A1.2-1) was conducted by ATO-W ATC Spectrum Engineering Services to estimate the gain in frequency assignments to be obtained from the 25 improvement measures. The system assumptions used in this study are summarized as follows:

- 1) The continental U.S. was approximated by a rectangular figure 2,300 nautical miles (NM) wide by 1,200 NM high, and the resulting area was used to determine the number of assignments.
- 2) Alaska, Hawaii, and U.S. Possessions were left out of the study, since these areas are not subject to immediate frequency congestion problems. Therefore, an attempt was made to segregate the data from these areas. The combined frequency usage in these areas represents approximately 10 percent of the total number of assignments and 5 percent of the enroute frequency assignment usage.
- 3) Only the co-channel engineering criteria was factored into the calculations (it should be noted that co-site and adjacent channel considerations will somewhat reduce the actual number of possible assignments).
- 4) The assignments were to be made at the minimum distance that results in a 14 dB protection ratio.
- 5) The enroute service volume (i.e., coverage area) was defined as being 100 NM and 45,000 ft. This is a conservative assumption resulting in allowing co-channel assignments to be made using a 700 NM separation between stations. Using this separation, a total of five enroute assignments across the U.S. can be made per channel.

6) The approach control service volume (i.e., coverage area) was defined as being 60 NM and 25,000 ft. Co-channel assignments can be made using a 420 NM separation between stations. Using this separation, a total of 15 assignments across the CONUS can be made per channel. The local control service volume was defined as being 30 NM and 10,000 ft. Co-channel assignments can be made using a 210 NM separation between stations. Using this separation, a total of 62 assignments can be made across the CONUS per channel. In estimating the benefits to be gained for making terminal assignments, it is assumed that half of the channels are used for making approach control assignments, and the other half are used for making local control assignments.

7) The AWOS/ASOS service volume was defined as being 25 NM and 10,000 ft. Co-channel assignments can be made using a 150 NM separation between stations. Using this separation, a total of 122 assignments across the CONUS can be made per channel.

8) The frequency assignments estimated to be possible for the three categories (i.e., enroute, terminal, and broadcast services) are mutually exclusive. For example, a frequency assumed to be used to make enroute assignments could not then also be used for another function (i.e., terminal or broadcast).

3. INTRODUCTION AND SUMMARY OF THE 25 IMPROVEMENT MEASURES

3.1 In this section, the 25 improvement measures are introduced and summarized, including a brief description of the measure, the action being taken, the expected improvement to be gained, and the planned implementation action.

1) INVESTIGATE THE USE OF PART OF THE 121.5 MHZ GUARD BAND FOR ATS ASSIGNMENTS.

SUMMARY OF PROPOSED ACTION:

The emergency frequency, 121.5 MHz, has a 100 kHz guard band around it. Polar orbiting satellite receivers are used to monitor for Emergency Locator Transmitter (ELT) transmissions. Both the United States and Russia have such satellite receiving systems, collectively known as COSPAS/SARSAT. The objective of this improvement measure is to pursue the use of four of the six guard band channels around 121.5 MHz (121.425 MHz, 121.450 MHz, 121.550 MHz, and 121.575 MHz) to be used for low power, ground broadcast transmission functions only, with strict out-of-channel emission specifications, to ensure protection of the existing satellite receivers. In practice, existing broadcast services would be moved to these channels, thus freeing up the other channels for general ATS use. New broadcast services would also be assigned to these channels. (See related Improvement Measure Number 9 below).

**COORDINATION/FINANCIAL SUPPORT/TECHNICAL SUPPORT
NECESSARY:**

Coordination of tests with concerned United States agencies would be required to ensure that the broadcast transmissions would not cause interference to the 121.5 MHz emergency signal alerting via satellite, to FAA direction finding facilities, and to Civil Air Patrol (CAP) onboard direction finders (DF). Further communication with the ICAO would be necessary to record an exception to the ICAO SARPs, and to subsequently work to change the present ICAO standards related to this issue.

IMPLEMENTATION STATUS (IN PROGRESS):

Six FAA ASOS/AWOS stations in the Eastern U.S. have been retuned to operate on the allowed outer 121.5 MHz guard band channels. As a result of satisfactory operation at these six stations, a subsequent implementation of up to 100 operational broadcast frequency assignments on the four channels highlighted above was begun in September 2004.

FUTURE WORK:

Begin coordination with the NTIA and the FCC to make needed regulatory changes to recognize the use of the selected 121.5 MHz guard band frequencies for selected ATS broadcast services, using stringent transmission criteria;

Begin coordination with ICAO to record a U.S. exception for the use of the selected 121.5 MHz guard band frequencies for ATS, and work to change ICAO standards to broadly allow such usage; and

Assuming a satisfactory outcome of the implementation of the 100 assignments, implement a broader general usage of the four guard band channels for broadcast services.

**2) SEEK ALTERNATIVE CHANNELS FOR THE CURRENT TWO
FLIGHT CHECK FREQUENCIES.**

SUMMARY OF PROPOSED ACTION:

ATO-W ATC Spectrum Engineering Services is seeking to gain access to two alternate channels for use by FAA flight check, thus freeing up the two present flight check coordination frequencies (135.85 MHz or 135.95 MHz) for general ATS use. As a first measure, coordination with the Aerospace Flight Test Radio Coordinating Council (AFTRCC) is proposed to seek the use of 123.175 MHz for FAA flight check operations as the primary frequency. A footnote in the U.S. Radio Regulations allows 123.175 MHz

to be used on a non-interference basis for flight check coordination purposes. In coordinating with the AFTRCC, ATO-W ATC Spectrum Engineering Services also sought the use of other flight test frequencies below 136 MHz that could then be made available for ATS usage, in exchange for frequency resources above 136 MHz. It was learned during early investigation that the ground maintenance radios (used in coordinating with the airborne flight check aircraft) could not tune above 136 MHz. Therefore, new maintenance radios would also be needed to allow the two flight check coordination frequencies to be moved above 136 MHz.

**COORDINATION/FINANCIAL SUPPORT/TECHNICAL SUPPORT
NECESSARY:**

Coordination with AFTRCC, ATO-W Aviation System Standards, and the FAA Flight Standards Service (AFS) would be needed to determine if a change in the flight check frequencies could be carried out. Coordination with Canada and Mexico should be undertaken to help ensure that there will be no interference to ATS in the NAS while using either of the flight check frequencies (since, e.g., Canada uses the same flight check frequencies as the FAA).

IMPLEMENTATION STATUS (IN PROGRESS):

Test use of 123.175 MHz resulted in interference to flight check missions caused by AFTRCC users and other sources. Further discussion has been held with ATO-W ATC Communications Services to make a change to the NEXCOM program, to purchase new 760 channel maintenance radios. All flight check aircraft are equipped to operate above 136 MHz.

FUTURE WORK:

ATO-W ATC Spectrum Engineering Services coordinate with ATO-W Aviation System Standards to pursue a long-term flight check frequency coordination usage solution;

Coordinate with Canada and Mexico to ensure that there would be no interference in the ATS usage of flight check frequencies; and

Pursue the early availability of new maintenance radios capable of tuning above 136 MHz.

3) INVESTIGATE/REVIEW THE CURRENT USE OF LAW ENFORCEMENT CHANNELS AND IDENTIFY ALTERNATIVE FREQUENCIES FOR THEIR USE, E.G., UHF/LAND MOBILE.

SUMMARY OF PROPOSED ACTION:

Both the Department of Justice (DOJ) and the Department of Homeland Security (DHS) have been assigned an ATS frequency nationwide to support law enforcement. The objective of this improvement measure is to seek phasing out operations on either or both of these frequencies, or at least move them temporarily above 136 MHz, so that the released channels below 136 MHz could be made available to satisfy ATS requirements.

COORDINATION/FINANCIAL SUPPORT/TECHNICAL SUPPORT NECESSARY:

Coordinate with DHS and DOJ to gain acceptance to free up two ATS frequencies below 136 MHz for ATS usage in the near term, by moving their usage above 136 MHz. In the longer term acceptance to a plan to move completely out of the ATS VHF band should be sought by the FAA.

IMPLEMENTATION STATUS (IN PROGRESS):

A DHS frequency has been made available to satisfy an enroute assignment for the Geauga Sector (Cleveland Center), which was commissioned in November 2001. By July 9, 2004, this frequency was recovered for ATC use anywhere in the NAS.

FUTURE WORK:

Coordinate a meeting with DOJ to pursue the goal of establishing a plan to move out of the ATS VHF band;

Coordinate a meeting with DHS to pursue the goal of establishing a plan to move out of ATS VHF band;

DOJ submit a frequency change request to use a frequency above 136 MHz;

DOJ transition out of the 118-137 MHz band; and

DHS transition out of the 118-137 MHz band.

4) REVIEW THE FCC USE PLAN, INCLUDING INVESTIGATING THE USE OF UNICOM AND OTHER FCC AERONAUTICAL FREQUENCIES FOR ATS.

SUMMARY OF PROPOSED ACTION:

The 66 channels in the frequency band 121.950 to 123.575 MHz (inclusive) are allocated for non-ATS functions. The 37 non-FSS channels (the FSS channels are addressed in Improvement Measure 5 below) are assigned to other functions and are managed by the FCC. Of these 37 channels, 8 are UNICOM frequencies and 17 are flight test frequencies. The 25 kHz UNICOM (122.725, 122.975, and 122.075) and some of the 17 flight test channels appear to represent the best targets for obtaining additional ATS frequencies. The objective of this improvement measure is to seek re-assignment of at least some of these frequencies for ATS usage. In the longer term, the U.S. allocation of these frequencies would need to be changed to the AM(R)S, to make the allocation consistent with ATS usage (i.e., for safety communications).

COORDINATION/FINANCIAL SUPPORT/TECHNICAL SUPPORT NECESSARY:

Coordination with the AFTRCC, the AOPA, and the FCC would be needed to discuss the possibilities of using these frequencies for ATS. In addition, coordination with the NTIA and the FCC would be needed to pursue a domestic reallocation of these frequencies.

IMPLEMENTATION STATUS (IN PROGRESS):

Since there is increasing usage on the UNICOM channels, no UNICOM channels could be recovered for ATS usage. However, AFTRCC is agreeable to considering a swap to use a frequency above 136 MHz, in exchange for a flight test frequency below 136 MHz. A preliminary review of data from AFRTCC indicates that an estimated cost of several million dollars would be required to procure transceivers to allow a significant amount of AFTRCC operations to transition above 136 MHz. The NTIA supports the FAA initiative to consider the domestic reallocation of selected flight test frequencies to the AM(R)S.

FUTURE WORK:

Continue coordination with the AFTRCC to gain identified additional spectrum resources for ATS from industry test frequencies;

Coordinate with Canada and Mexico, when appropriate and necessary, to ensure that any future planned usage of flight test frequencies for ATS will not be subject to interference from cross border transmissions; and

Coordinate with the FCC, when appropriate, to consider the domestic reallocation of selected flight test frequencies to the AM(R)S.

5) INVESTIGATE THE POSSIBILITY OF USING FSS CHANNELS FOR ATS, INCLUDING THE FREQUENCIES 123.6 MHZ THROUGH 123.65 MHZ.

SUMMARY OF PROPOSED ACTION:

The 25 kHz channels in the FSS band, 121.975-122.675MHz (see FCC Part 87, Paragraph 87.173 "Frequencies", Subparagraph Y, Item (2)), are viewed as being under used or not used at all. In addition, 123.6-123.65 MHz (inclusive), identified as FSS Air Carrier Advisory Channels, are very much under used. The purpose of this improvement measure is to seek use of these channels for ATS. The Air Carrier Advisory Channels were intended for use by FSS's to provide advisory services at airports where there was an FSS and no UNICOM. With the consolidation of the FSS's into Automated FSSs (AFSS), this usage was no longer continued as a routine service. It is considered that no regulatory changes will be needed to use these frequencies (123.6-123.65 MHz) for ATS. However, with regard to the FSS band, severe ATS usage constraints exist, since the FSS band is limited to "private aircraft stations", and is not allocated to the AM(R)S.

COORDINATION/FINANCIAL SUPPORT/TECHNICAL SUPPORT NECESSARY:

Coordination with FAA Air Traffic Organization Flight Services (ATO-D) Flight Services Safety and Operations Support regarding the usage of the "Air Carrier Advisory Channels" is needed to transition the remaining usage on these channels to the FSS channels. For the longer term usage of the FSS channels for ATS, coordination will be needed with the NTIA and the FCC to seek the reallocation of the FSS channels to the AM(R)S.

IMPLEMENTATION STATUS (IN PROGRESS):

Action was taken to make the "Air Carrier Advisory Channels" (123.6-123.65 MHz) available for ATS. Some FAA air traffic orders concerning these channels remain to be changed (ATO-D Flight Services Safety and Operations Support task). AOPA indicated they would have no problem with the FAA using FSS channels for ATS, provided that there would be no interference or degradation to present FSS services. The FCC has issued a waiver to use 122.275 MHz for ATS usage.

FUTURE WORK:

Complete the FCC Part 87 change which will remove the private aircraft-only use limitation, allowing a permanent future basis for the use of FSS channels for ATS; and

Clear the remaining FSS channel assignments from three "Air Carrier Advisory Channels" (123.6-123.65 MHz) for ATS usage.

6) INVESTIGATE THE USE OF THE BAND SEGMENT 136-137 MHZ FOR ATS.

SUMMARY OF PROPOSED ACTION:

Presently, a part of the 136-137 MHz band segment (136-136.475 MHz) could be used for ATS (two of the 20 available frequencies will continue to be assigned to digital flight information services, as part of the FISDL program, on a temporary basis (to 2011)). The objective of this improvement measure is to seek the use of this new spectrum resource for ATS voice communications. Since 70 percent of the commercial aircraft that fly in Class B (high altitude) airspace are equipped with 760 channel radios, ATO-W ATC Spectrum Engineering Services will seek to use the available portion of the 136-137 MHz band segment for high altitude enroute sectors. In addition, ATO-W ATC Spectrum Engineering Services will seek to move other services (See related Improvement Measures 2, 3, and 4) to 136-136.475 MHz (largely on a temporary basis) in exchange for the use of frequencies below 136 MHz for ATS usage.

COORDINATION/FINANCIAL SUPPORT/TECHNICAL SUPPORT NECESSARY:

Coordination with ATO-E and ATO-T, and the users that routinely fly in the upper airspace (in particular commercial and business aviation, and the DOD) will be required to seek agreements on the usage of channels above 136 MHz in selected sectors.

IMPLEMENTATION STATUS (IN PROGRESS):

FUTURE WORK:

Coordinate within FAA to seek opportunities of geographic locations and airspace applications (e.g., high altitude) for using channels above 136 MHz for ATS; and

Coordinate with selected segments of the user community to pursue the use of channels above 136 MHz for ATS, and undertake appropriate rulemaking to effect this usage.

7) REVIEW STANDARD SERVICE VOLUME GUIDELINES IN ORDER 6050.32.

SUMMARY OF PROPOSED ACTION:

The purpose of this improvement measure is to press for changes in the standard service volume (i.e., coverage) following a review of the results of the frequency audit conducted by ATO-E and ATO-T. There are several standard service volumes depicted in Appendix 2 of FAA Order 6050.32A. Service volumes can be wasteful in both horizontal area and altitude. ATO-E and ATO-T were aware of this improvement measure, and ensured that the frequency audit data included information to allow the service volume needs to be considered for the frequency assignments.

COORDINATION/FINANCIAL SUPPORT/TECHNICAL SUPPORT NECESSARY:

Coordination between ATO-E and ATO-T, and the FMOs will be needed to ensure that a productive examination of the service volumes can be carried out.

IMPLEMENTATION STATUS (IN PROGRESS):

A decision has been made to specify coverage areas based on actual requirements rather than a fixed service volume for specific services. The next revision of FAA Order 6050.32 will specify coverage areas based on actual requirements rather than a fixed service volume for specific services.

8) INVESTIGATE THE USE OF DIRECTIONAL ANTENNAS FOR SELECTED APPLICATIONS.

SUMMARY OF PROPOSED ACTION: (NOT IMPLEMENTED)

The objective of this improvement measure is to pursue the possibility of seeking a more widespread use of directional antennas as a possible means of improving spectrum use efficiency. Certain frequency applications may allow the use of directional antennas, since the communications with pilots may be isolated to certain directions. After investigation, including a meeting with ATO-E and ATO-T, it was concluded that it would not be cost beneficial to pursue this improvement measure further. Considerations taken into account in making this decision, were the following: (a) directional antennas

are already in use in some applications, and (b) there wouldn't be much of an improvement in spectrum use efficiency even if the remaining uses for directional antennas were implemented.

9) REVIEW AND REASSESS POLICY OF ASSIGNING AWOS AND ASOS IN SUB-BAND.

SUMMARY OF PROPOSED ACTION:

In order to improve the utilization of the 118-137 MHz band, the number of frequencies reserved for specific uses needs to be minimized. This measure is aimed at eliminating the sub-band reserved for broadcast services (including ATIS, AWOS, and ASOS). It has been proposed that the emergency guard band frequencies (See Improvement Measure 1), as well as 120.000 MHz (on which interference is received from certain FAA computer equipment), will be the only frequencies reserved solely for broadcast services; these frequencies would be the first choice for all new Government AWOS/ASOS assignments. It is also planned to approve the use of these frequencies for ATIS assignments, to the extent that the reduced transmit power restrictions on the guard band frequencies may satisfy ATIS requirements.

COORDINATION/FINANCIAL SUPPORT/TECHNICAL SUPPORT NECESSARY:

Assistance from the FMOs is needed to draft new guidelines covering the conditions for moving present broadcast assignments and making new broadcast assignments.

IMPLEMENTATION STATUS (IN PROGRESS):

New guidelines, which significantly modify the selection criteria for making frequency assignments for broadcast services, were drafted, approved, and communicated to concerned field organizations. These new guidelines are being used by ATO-W ATC Spectrum Engineering Services. The AFM has been changed to include a means of selecting new broadcast frequency assignments consistent with the new guidelines. The next revision of FAA Order 6050.32 will include these new guidelines.

FUTURE WORK:

Update AWOS Advisory Circular (Number 150/5220-16C dated 12/13/99) to reflect the new guidelines.

10) REVIEW ASSIGNING GROUND CONTROL IN SUB-BAND.

SUMMARY OF PROPOSED ACTION:

This measure is aimed at eliminating the sub-band reserved for GC communications frequency assignments. Subsequent to this change, new GC frequency assignments will be selected from the broader band segments of frequencies available for ATS.

COORDINATION/FINANCIAL SUPPORT/TECHNICAL SUPPORT NECESSARY:

Coordination with the FCC and the NTIA is needed to update Part 87 and the NTIA Manual, respectively, to reflect the broader frequency band to be allowed in the selection of GC frequency assignments. Coordination is needed with Canada and Mexico to ensure that this new flexibility is reflected in the cross-border frequency coordination guidance, and with ICAO to eliminate sub-banding.

IMPLEMENTATION STATUS (IN PROGRESS):

The AFM has been modified to eliminate sub-bands in making GC frequency assignments. The next revision of FAA Order 6050.32 will reflect this new policy.

FUTURE WORK:

Coordinate with FCC and complete update of Part 87;

Update Advisory Circular 90-50 to reflect this new policy;

Coordinate with Canada and Mexico regarding the elimination of the use of sub-bands in making GC frequency assignments; and

File an exception with ICAO regarding the elimination of the use of sub-bands in making GC frequency assignments.

11) CONDUCT ATS FREQUENCY AUDIT.

SUMMARY OF PROPOSED ACTION:

The objective of this improvement measure is to gain spectrum resources resulting from the identification of unused, underused, or misused frequency assignments. To accomplish this objective, ATO-E and ATO-T have conducted a broad frequency assignment audit within the NAS. A first level exercise was envisioned to

identify frequency assignments that were no longer being used and to discover minor discrepancies in frequency assignment usage (Phase I). A follow-on effort was planned to analyze the frequency assignments in a more detailed manner, to validate the functional usage of the scarce spectrum resources (Phase II). A sizable gain in spectrum resources is expected, which would be used to satisfy new requirements (the goal established was to recover one percent of the assignments).

**COORDINATION/FINANCIAL SUPPORT/TECHNICAL SUPPORT
NECESSARY:**

Coordination with ATO-E, ATO-T, and the FMOs is needed to accomplish this objective.

IMPLEMENTATION STATUS (IN PROGRESS):

In the Phase I portion, a validated list of 43 VHF and 27 UHF frequency assignments were identified to be recovered. Subsequently, the FMOs updated the Government Master File (GMF).

FUTURE WORK:

Complete a more comprehensive and detailed analysis of the frequency assignments and update the GMF for all FAA Air Route Traffic Control Centers (ARTCCs);

Complete a more comprehensive and detailed analysis of the frequency assignments and update the GMF for all tracons and airports; and

Complete a more comprehensive and detailed analysis of the frequency assignments and update the GMF for all AFSSs.

**12) INVESTIGATE IMPROVED CO-SITE MITIGATION
TECHNIQUES.**

SUMMARY OF PROPOSED ACTION:

The objective of this improvement measure is to investigate, and implement as appropriate, possible data base information and technical improvements to mitigate the potential for co-site interference at ground receiver and transmitter sites. The candidate improvements include the use of, or increased use of, as appropriate: a) filters, multicouplers, and combiners; b) separate sites for transmitters and receivers; c) stacked antennas; d) other existing sites to separate receiver(s) and transmitter(s); e) reduce power

for terminal services; f) eliminate power amplifiers; g) redefine intermodulation criteria by taking into consideration transmitter power and receiver sensitivity; and h) raising the receiver squelch threshold.

**COORDINATION/FINANCIAL SUPPORT/TECHNICAL SUPPORT
NECESSARY:**

Close coordination among ATO-W ATC Spectrum Engineering Services, the FMOs, and ATO-W ATC Communications Services would be necessary to evaluate and implement a combination of these measures.

IMPLEMENTATION STATUS (IN PROGRESS):

The FAA William J. Hughes Technical Center has conducted flight tests resulting in a conclusion that the majority of clearance delivery and ground control requirements could be satisfied with a transmitter power of 5 watts.

FUTURE WORK:

FAA William J. Hughes Technical Center develop transmitter/receiver co-site frequency engineering criteria for use on case-by-case basis;

Decide which co-site improvements will be implemented; and

Modify the AFM as required.

13) REVIEW AIR SHOW FREQUENCY ASSIGNMENT POLICY.

SUMMARY OF PROPOSED ACTION:

The objective of this improvement measure is to investigate the FAA's air show frequency assignment policy to see if any channels could be released for operational use. It should be noted that frequencies assigned to specific air shows are used in the NAS to satisfy ATS requirements in other areas. "Start" and "stop" dates for other air show frequency assignments will be sought, thereby allowing the same frequency to be reused at different air shows.

**COORDINATION/FINANCIAL SUPPORT/TECHNICAL SUPPORT
NECESSARY:**

Coordination between ATO-W ATC Spectrum Engineering Services and the FMOs will be necessary to develop a means to reduce the number of air show frequency assignments. In addition, coordination with ATO-E and ATO-T will be necessary to ensure that safety is maintained at the air shows.

IMPLEMENTATION STATUS (IN PROGRESS):

A modification of the AFM to allow the provision of "start" and "stop" dates for air show frequency assignments was completed. The next revision of FAA Order 6050.32 will include guidance for making air show frequency assignments. The FAA Central Service Area developed draft guidelines to more spectrum efficiently support air shows.

FUTURE WORK:

Develop a final draft of the guidelines and communicate the resultant policy to the FMOs.

**14) REVIEW FIRE-FIGHTING FREQUENCY ASSIGNMENT
POLICY.**

SUMMARY OF PROPOSED ACTION:

ATS frequencies are used for coordination in support of aerial water drops on wildfires in areas inaccessible to ground based fire-fighting equipment. The coordination of seasonal fire-fighting frequencies was traditionally accomplished on a local level through the FAA FMOs. In recent years, much of the local coordination has been assumed by the National Interagency Fire Center (NIFC) in Boise, Idaho. In an effort to reduce the numbers of frequencies reserved for fire-fighting, much of the FAA service area coordination (especially east of the Mississippi) has been through ATO-W ATC Spectrum Engineering Services. However, in some cases six frequencies have been assigned to an area, and in a recent year there were as many as 349 assignments in the pending file to support fire-fighting. The purpose of this measure is to seek a reduction, and more efficient use, of frequency assignments used for fire-fighting coordination.

**COORDINATION/FINANCIAL SUPPORT/TECHNICAL SUPPORT
NECESSARY:**

Close coordination will be needed between ATO-W ATC Spectrum Engineering Services, the FMOs, and the NIFC to ensure that a minimum number of ATS frequencies will be requested for fire-fighting coordination. Coordination with the FCC will also be needed to consider the possibility of using flight test frequencies for fire-fighting coordination.

IMPLEMENTATION STATUS (IN PROGRESS):

As a result of a meeting with the NIFC, some changes to the frequency assignment policy were made. These changes included a reduction in the number of frequencies assigned to fire-fighting areas to a single frequency, and only adding additional frequencies as needed.

FUTURE WORK:

ATO-W ATC Spectrum Engineering Services and selected FAA service area representatives meet with NIFC and AFTRCC to discuss the long-range plan for frequency use, with a view of moving fire fighting coordination out of the ATS VHF band, or, as a temporary measure, establish use above 136 MHz.

**15) REVIEW USE OF VHF FREQUENCIES BY THE MILITARY
AND THE USE OF THE MILITARY COMMON FREQUENCIES
126.2 MHZ AND 134.1 MHZ.**

SUMMARY OF PROPOSED ACTION:

The objective of this improvement measure is to gain release of the frequencies 126.2 MHz and 134.1 MHz (and other VHF A/G frequency assignments used by DOD) from the DOD; these frequencies would be used to satisfy ATS A/G communications requirements. This initiative was taken because it is believed that these frequencies and other frequency assignments are not being used for valid ATS communication purposes. The DOD has other VHF A/G frequency assignments to satisfy ATS functions. There are about 45 DOD related frequency assignments on these two frequencies nationwide. In addition, the FAA will pursue the recovery of other VHF A/G frequency assignments from DOD.

**COORDINATION/FINANCIAL SUPPORT/TECHNICAL SUPPORT
NECESSARY:**

Coordination with the Executive Secretary, DOD Policy Board on Federal Aviation (PBFA) is necessary to raise this issue and to gain an agreement to recover these frequencies for general ATS usage.

IMPLEMENTATION STATUS (IN PROGRESS):

In a meeting, the Executive Secretary, DOD PBFA, endorsed the idea that the DOD would carry out a spectrum audit on VHF A/G usage. A follow-up meeting was held with DOD spectrum planners. They planned to complete a directive for the Executive Secretary, DOD PBFA, for DOD to conduct such an audit. In January 2004, ATO-W ATC Spectrum Engineering Services sent a follow-up letter to the DOD PBFA requesting a status report on the use of 126.2 MHz and 134.1 MHz.

FUTURE WORK:

A status report on the promised frequency audit is expected from the DOD PBFA as the next step in seeking to gain the usage of 126.2 MHz and 134.1 MHz.

**16) INVESTIGATE USE OF VOR FREQUENCIES FOR AWOS AND
ASOS BROADCAST FUNCTION ONLY.**

SUMMARY OF PROPOSED ACTION:

The objective of this improvement measure is to consider the potential of using VOR frequency assignments to implement VHF ground-to-air broadcast transmitters for AWOS and ASOS, thereby freeing up frequencies within the 118-137 MHz band to satisfy other ATS requirements. Tests would be needed to determine suitable ground transmission characteristics, to ensure satisfactory reception within the defined service volumes. It is recognized that frequency allocation issues would need to be addressed.

**COORDINATION/FINANCIAL SUPPORT/TECHNICAL SUPPORT
NECESSARY:**

Coordination between the FAA William J. Hughes Technical Center (conducting the testing), and ATO-W ATC Spectrum Engineering Services and the FMOs is needed to ensure that the testing and results reflect realizable ground site capabilities and a satisfactory service, respectively. Sizable flight test costs could be expected, unless the tests could be incorporated on other test flights. If deemed feasible, further coordination

will be necessary with other FAA offices, and with the NTIA, the FCC, and ICAO on the frequency allocation issue.

IMPLEMENTATION STATUS (IN PROGRESS):

It has been concluded from flight tests that it would be technically feasible to use VOR frequencies for AWOS and ASOS broadcasts, assuming the use of a circularly polarized ground antenna and a 10 Watt transmitter.

FUTURE WORK:

ATO-W ATC Spectrum Engineering Services complete coordination with the FAA Air Traffic Organization System Operations Services (ATO-R) System Operations Programs, AFS, ATO-E, and ATO-T on a new use of VOR frequencies for AWOS and ASOS;

ATO-W ATC Spectrum Engineering Services develop an implementation policy and frequency assignment criteria for the use of VOR channels;

ATO-W ATC Spectrum Engineering Services ensure the Aeronautical Information Manual is updated as necessary to avoid pilot confusion in the use of voice communications only on VOR channels;

ATO-W ATC Spectrum Engineering Services conduct initial coordination with NTIA and the FCC to address the frequency allocation issue; and

ATO-W ATC Spectrum Engineering Services conduct coordination with ICAO to address the frequency allocation issue.

17) INVESTIGATE USE OF OFFSET CARRIER OPERATION FOR HIGH ALTITUDE AND GROUND SERVICE.

SUMMARY OF PROPOSED ACTION:

The objective of this improvement measure is to consider the possibility of using offset carrier operations for very large sectors where a single ground site cannot provide adequate coverage. Presently, in such coverage situations, multiple frequencies or selective keying (see Improvement Measure Number 18) are used to provide coverage. Using multiple frequencies is spectrum inefficient, and selective keying has been viewed by some as too labor intensive. With offset carrier operations, multiple ground transmitters (covering a large sector) would be tuned to the same frequency, but offset by, for example, + and – 6 kHz from the center frequency assignment. The receiver would automatically "lock onto" one of the offset carriers and suppress the others. Such a

frequency offset system might also be capable of covering GC blind spots at airports. Offset carrier operations have been used to provide AOC for years. Other countries also use offset carrier operations for ATS. A major concern in the NAS is the inadequate specifications of some general aviation radios; an audio heterodyne tone may result. Analysis and tests will be conducted to determine the implementation potential of this measure in selected situations in the NAS.

**COORDINATION/FINANCIAL SUPPORT/TECHNICAL SUPPORT
NECESSARY:**

Coordination among ATO-W ATC Spectrum Engineering Services, the FMOs, ATO-E, ATO-T, and the FAA William J. Hughes Technical Center are necessary to consider the potential areas where this improvement measure can be implemented, and to conduct feasibility tests of this capability. Sizable flight test costs could be expected, unless the tests could be incorporated on other test flights.

IMPLEMENTATION STATUS (IN PROGRESS):

It was determined that offset carrier operations could be successful for air carrier use; however, this initiative has been put on hold pending consideration of whether to extend the use of select key operations or to proceed with offset carrier usage.

FUTURE WORK:

FAA William J. Hughes Technical Center complete operational test of offset carrier operations; and

Establish a program to implement the use of offset carrier operations in the NAS.

**18) INVESTIGATE THE USE OF MORE SELECT KEYING AND
VOTING SYSTEMS, INCLUDING REVIEWING THE ATO-E
POLICY ON SIMULCAST TRANSMISSIONS.**

SUMMARY OF PROPOSED ACTION:

The objective of this improvement measure is to gain an increased use of a single frequency to cover large enroute airspace sectors that now use more than one frequency to obtain the needed coverage. In very large enroute airspace sectors, several remote communications A/G sites (RCAGs) are required for coverage. Some of these sectors use transmitters tuned to different frequencies; all the transmitters are activated when the controller wishes to talk, a function known as "multicast transmissions". In many areas, a more spectrum efficient function known as "select keying" is used; all the transmitters are

tuned to the same frequency, and the controller selects the transmitter to key when calling an aircraft (based on the known position of the aircraft). On the receive side, a "receiver voting system" is used when using a single frequency for the large sector; the Voice Switching and Control System (VSCS) selects the first received signal from the RCAG receiver sites placed in the voting system. FAA Order 6510.4A, Radio Communications Requirements for Air Traffic Control Facilities, specifies that select keying should be used to avoid requiring additional frequency assignments.

**COORDINATION/FINANCIAL SUPPORT/TECHNICAL SUPPORT
NECESSARY:**

Coordination among ATO-W ATC Spectrum Engineering Services, the FMOs, and ATO-E are necessary to both address this issue and adopt, if possible, a revised policy to use "select keying" as the primary means for establishing coverage in large sectors where more than one communications outlet is needed.

IMPLEMENTATION STATUS (IN PROGRESS):

Study has revealed that select keying used in conjunction with the voting system is in use to some extent throughout the NAS. In the FAA Central Service Area (in the former Great Lakes Region), simulcasting on multiple frequencies, each located at a different RCAG site, was the primary method selected long ago to provide coverage in large sectors, and simulcasting on multiple frequencies is used in a number of FAA service areas to some extent. ATO-W ATC Spectrum Engineering Services has communicated with ATO-E to ensure that the simulcasting issue is addressed in the ATO-E and ATO-T frequency audit (Improvement Measure Number 11).

FUTURE WORK:

ATO-W ATC Spectrum Engineering Services develop a memo which highlights that single-sector multi-frequency simulcast is spectrum inefficient, and any assignment of more than one frequency per sector shall be operationally justified;

FAA William J. Hughes Technical Center consider the operational suitability of possible solutions for providing coverage to large areas, or other areas, where it is not possible to provide suitable coverage from a single ground site;

ATO-W ATC Spectrum Engineering Services brief FAA Central Service Area ATO-E on the spectrum usage impact of multi-frequency simulcast operations, and the need to transition to select keying (and/or offset carrier operations, if deemed appropriate); and

FAA Western Service Area prepare a statement of work to investigate the potential benefit of synchronizing transmissions from multiple sites to allow a phase locked operation.

19) INVESTIGATE LOWERING GROUND CONTROL TRANSMITTER ANTENNA HEIGHT AND POWER OUTPUT, IF POSSIBLE AND PRACTICAL, PROVIDED NECESSARY COVERAGE IS MAINTAINED.

SUMMARY OF PROPOSED ACTION:

The objective of this improvement measure is to gain improved spectrum use efficiency and a reduction in Radio Frequency Interference (RFI) problems, by potentially lowering the height of GC antennas and establishing a nominal transmitter power of 2.5 or 5 Watts. (This measure is to be pursued in parallel with Improvement Measure 20.)

COORDINATION/FINANCIAL SUPPORT/TECHNICAL SUPPORT NECESSARY:

Coordination between ATO-W ATC Spectrum Engineering Services and the FMOs will be needed to discuss the situation of the actual installations in the field. Subsequent coordination will be needed with ATO-W ATC Facilities to reach agreement on following the GC installation criteria.

IMPLEMENTATION STATUS (IN PROGRESS):

It has been concluded from study that GC antennas should not be higher than the antenna heights on commercial aircraft (found to be between 20 and 43 feet) using the GC service at the facility. In summary, GC antennas should be at the minimum required height (not greater than 50 feet) and transmitter power for effective communications with aircraft.

FUTURE WORK:

ATO-W ATC Spectrum Engineering Services meet with ATO-W ATC Facilities to discuss the need for new guidelines for GC antenna installation, to reinforce the importance of following these guidelines, and highlight other issues;

ATO-W ATC Spectrum Engineering Services draft revised guidelines for GC antenna installation, and distribute to ATO-W ATC Facilities and FMOs for comment;

FMOs complete review of revised guidelines for GC antenna installation, and provide comments to ATO-W ATC Spectrum Engineering Services; and

ATO-W ATC Spectrum Engineering Services communicate the new guidelines to ATO-W ATC Facilities for implementation.

20) INVESTIGATE THE ADVANTAGES RESULTING FROM THE OPTIMIZATION OF THE GROUND EQUIPMENT GEOGRAPHICAL LOCATION WITH RESPECT TO THE SERVICE VOLUME.

SUMMARY OF PROPOSED ACTION:

The objective of this improvement measure is to take advantage, if possible, of the increased spectrum utilization efficiency that would result from implementing more optimally spaced RCAGs within their associated service volumes. Presently, the locations of RCAGs are rarely within the center of the associated service volumes. Study will be undertaken of a number of geographic areas to evaluate the differences in distances between existing RCAGs and more optimally spaced RCAGs (which would occur from the implementation of ideally centered RCAGs within the coverage volumes). While it may not be cost beneficial to move a large number of communication sites to the center of their respective service volumes, some gain could be expected for selected site changes. (This measure is to be pursued in parallel with Improvement Measure 19.)

COORDINATION/FINANCIAL SUPPORT/TECHNICAL SUPPORT NECESSARY:

Close coordination between ATO-W ATC Spectrum Engineering Services and the FMOs, and subsequently among ATO-W ATC Spectrum Engineering Services, ATO-W ATC Facilities, ATO-E, and ATO-T would be necessary to fully address this measure, and ensure that the new guidance material for ATO-W ATC Facilities usage is as complete and clear as possible.

IMPLEMENTATION STATUS (IN PROGRESS):

A significant potential gain was indicated in studying 30 tailored service volumes (TSVs). Due to such considerations as cost and other variables, it was recommended that only new RCAG sites should be considered on a case by case basis with very close coordination with ATO-E and ATO-T. It was also recognized that some gain could be expected for selected site changes where frequency congestion is a severe problem.

FUTURE WORK:

ATO-W ATC Spectrum Engineering Services meet with ATO-W ATC Facilities to discuss the possible need for new engineering guidelines for new or relocated communication site installations;

ATO-W ATC Spectrum Engineering Services draft new engineering guidelines, if appropriate, for new or relocated communications sites, and distribute to ATO-W ATC Facilities and the FMOs for comment;

FMOs complete review of revised guidelines for new or relocated communication sites, and provide comments to ATO-W ATC Spectrum Engineering Services; and

ATO-W ATC Spectrum Engineering Services communicate the new guidelines to ATO-W ATC Facilities for implementation.

21) MODIFY THE AFM DATABASE TO ACCEPT ADDITIONAL DATA AND MODIFY THE FREQUENCY ASSIGNMENT MODEL TO WORK WITH THESE NEW DATA.

SUMMARY OF PROPOSED ACTION:

The objective of this measure is to both improve spectrum utilization efficiency and reduce the potential for co-site interference problems, by providing additional data in the AFM with which to make a frequency assignment. Such data as transmitter/receiver antenna locations and heights, and the installation and impact of multi-couplers and combiners would be candidates for such data. In some situations it might be possible to provide satisfactory performance with a co-site frequency assignment criteria constraint of less than 500 kHz.

COORDINATION/FINANCIAL SUPPORT/TECHNICAL SUPPORT NECESSARY:

Close coordination would be needed between ATO-W ATC Spectrum Engineering Services and the FMOs to fully consider the possible data that might be included in the AFM, taking into consideration such issues as the complexity and usefulness of the candidate data.

IMPLEMENTATION STATUS (IN PROGRESS):

FUTURE WORK:

ATO-W ATC Spectrum Engineering Services in conjunction with the FAA William J. Hughes Technical Center will develop a candidate set of data to be considered for implementation in the AFM;

ATO-W ATC Spectrum Engineering Services prepare an AFM software change request to incorporate the candidate data set and distribute to the FMOs for review and comment; and

Integrate the FMO comments into the final software change, implement the change to the AFM, and communicate this change to the FMOs.

22) IMPROVE COORDINATION WITH ARINC AND OBTAIN A MORE ACCURATE DATABASE FROM THEM.

SUMMARY OF PROPOSED ACTION:

The objective of this improvement measure is to obtain a more detailed periodic database of frequency assignments from the ARINC master file. In particular, the location of the transmission sites around major airports would be helpful in making ATS frequency assignments, reducing the potential for RFI, and in determining the source of some cases of RFI.

COORDINATION/FINANCIAL SUPPORT/TECHNICAL SUPPORT NECESSARY:

Coordinate with the ARINC spectrum management staff to determine if additional coordination and a more frequent exchange of frequency assignment databases might be possible.

IMPLEMENTATION STATUS (ON HOLD):

As a result of coordination with ARINC, it was learned that ARINC does not keep a file of the locations of the transmitting antennas around the airports. The reason given for this is that the users are frequently moving their antennas around. Additional workload and related cost would be required to keep track of all the location changes of the many users at each major airport. ARINC indicated, however, that they might be able to obtain the locations and transmitted powers of the AOC related VHF A/G outlets at selected airports where frequency assignment congestion is severe. However, after further investigation, it was considered that there may be little gain to be obtained from this measure, and, consequently, further action has been put on hold.

23) REVISE THE AIR/GROUND MODEL TO ACCOMMODATE A 0.6 NAUTICAL MILE VERTICAL SEPARATION.

SUMMARY OF PROPOSED ACTION:

The frequency assignment criteria for assigning adjacent channels (i.e., the service volumes for adjacent 25 kHz frequency assignments) includes a horizontal minimum separation distance between the outer edges of the service volumes of 0.6 NM. However, no similar minimum separation distance has been established for vertical separation of the service volumes of adjacent channels. The purpose of this improvement measure is to implement and allow a vertical minimum separation distance of 0.6 NM between the service volumes of adjacent channels. This improvement is expected to yield a sizable spectrum use improvement, since this would allow, in many cases, the assignment of adjacent channels in the same geographical area.

COORDINATION/FINANCIAL SUPPORT/TECHNICAL SUPPORT NECESSARY:

An AFM software change to effect the inclusion of a 0.6 nautical mile adjacent channel vertical separation element will need to be drafted, coordinated with the FMOs, and implemented. Subsequent coordination to communicate this new AFM capability to the FMOs will be needed.

IMPLEMENTATION STATUS (IN PROGRESS):

A policy letter on the decision to change the AFM was sent to the FAA service areas. Subsequently, an AFM software change was developed and implemented, to include a 0.6 nautical mile adjacent channel vertical separation criterion. ATO-W ATC Spectrum Engineering Services communicated with the FMOs regarding this new AFM capability. The next revision of FAA Order 6050.32 will include the 0.6 nautical mile adjacent channel vertical separation criterion.

24) COMBINE HIWAS AND ASOS/AWOS SERVICE ON VOR CHANNELS.

SUMMARY OF PROPOSED ACTION: (NOT IMPLEMENTED)

The objective of this improvement measure is to investigate the possibility of combining HIWAS and AWOS/ASOS on a single VOR channel, taking into account operational and technical issues. HIWAS is a continuous broadcast of in-flight weather advisories. AWOS uses various sensors and a transmitter to broadcast local minute by minute weather data directly to pilots. Computer generated voice is used in AWOS to automate this information. ASOS is a similar broadcast service. Study concluded that

while it may be technically possible in some areas to piggyback the AWOS/ASOS signals with HIWAS information and transmit it on a single VOR carrier, it was considered that the costs versus benefits would not warrant further consideration of this measure. Further, there was a lack of support for this measure from ATO-E, ATO-T, and pilots (users were opposed to interruptions of the HIWAS transmissions for AWOS/ASOS). Other considerations included: (1) the need to ensure that the VOR would have the coverage needed by the other proposed services, (2) the need for communications links to interface AWOS/ASOS services with VOR transmitters, and (3) the question of which AWOS/ASOS information would get prioritized in a metroplex area where there was only one VOR.

25) MODIFY THE A/G MODEL TO GIVE RESULTS BY DISTANCE RATIO INSTEAD OF FREQUENCY ORDER.

SUMMARY OF PROPOSED ACTION:

The objective of this improvement measure is to modify the A/G model (of the AFM) so that users of the model would be presented with a list of possible frequency choices by distance ratio. That is, when seeking to make a frequency assignment, the user would be presented with the lowest possible distance ratio between the new service volume and that of an adjacent one as the first frequency of choice, with higher distance ratio possibilities presented further down on the list. Previously, the user had to take additional steps to find the lowest distance ratio. This improvement would help ensure that the frequency assignments are "packed" as tightly as possible, helping to ensure the best spectrum utilization efficiency.

COORDINATION/FINANCIAL SUPPORT/TECHNICAL SUPPORT NECESSARY:

An AFM software change would need to be drafted, coordinated with the FMOs, and submitted to the system automation support contractor for the change to be made. Subsequent coordination with the FMOs would be needed to ensure that they knew this new capability had been implemented in the AFM.

IMPLEMENTATION STATUS (IMPLEMENTED):

An AFM software change request was developed and implemented. Subsequently, ATO-W ATC Spectrum Engineering Services communicated this change to the FMOs.

4. SUMMARY OF GAIN FROM THE 25 IMPROVEMENT MEASURES

4.1 Table A1.2-1 below presents a status summary of the 25 improvement measures to date. The improvement numbers in the table conform to the improvement numbers as they have been addressed above in this appendix.

**Table A1.2-1: Status Summary of the 25 Improvement Measures
(End of FY-2004)**

Improvement Measure	FY - 2004			Cumulative Totals (Since 2001)		
	No. of Channels Gained	No. of Assignments Recovered	No. of Assignments Made**	No. of Channels Gained	No. of Assignments Recovered	No. of Assignments Made**
1 121.5 MHz Guard Band	---	---	5	4	7	17
2 Flight Check Frequencies	---	---	---	---	---	---
3 Law Enforcement Chs.	---	---	2	1	---	3
4 Review FCC Plan	---	---	1	1	---	1
5 FSS Chs.	---	---	---	3	---	---
6 136 - 137 MHz	---	---	45	---	---	292
7 Rev. Standard Service Volume	N/A	N/A	N/A	N/A	N/A	N/A
8 Directional Antenna*						
9 AWOS / ASOS sub-band	---	---	0	5	---	6
10 Grnd Control sub-band	---	---	2	13	---	8
11 ATS Freq. Audit	N/A	---	12	N/A	43	29
12 Improved Co-site Mitigation	N/A	---	---	N/A	---	---
13 Review Air Show	N/A	N/A	N/A	N/A	N/A	N/A
14 Review Firefight.	N/A	N/A	N/A	N/A	N/A	N/A
15 DOD use 126.2 / 134.1 MHz	---	---	---	---	---	---
16 VOR use for AWOS / ASOS	---	---	---	---	---	---
17 Offset carrier	---	---	---	---	---	---
18 Incr. Select Key / Voting Sys.	N/A	---	---	N/A	---	---
19 Lower Gnd Ctl. Tx Pwr/Ant. Ht.	N/A	---	---	N/A	---	---
20 Optimization site location	N/A	---	---	N/A	---	---
21 Mod. AFM to Accept Add. Data	N/A	---	---	N/A	---	---
22 Improve Coord. w/ ARINC	N/A	---	---	N/A	---	---
23 Accom. 0.6 Nmi Vert. Sep.	N/A	---	2	N/A	---	9
24 HIWAS/ASOS/AWOS on VOR*						
25 A/G Model Ch. for Dist. Ratio	N/A	N/A	N/A	N/A	N/A	N/A
Totals:	0	0	69	27	50	365

Notes:

* Measures that are not currently being pursued.

** Based on only "New Records" in the GMF.

Appendix 1.3 to Section 1

Basic Principles of Transition to the Next Generation System

1. Introduction

1.1 The purpose of this appendix is to provide additional information on the basic issues regarding the transition from the present VHF A/G voice communications system to the NEXCOM. The present voice system is based on DSB-AM and provides a single voice circuit on each 25 kHz radio frequency channel. NEXCOM is based on VDL-3, which utilizes TDMA technology to provide four independent communications circuits on each 25 kHz radio frequency channel. The four circuits can be any mix of voice and/or data link circuits. At the end of this appendix, in Section 3, a discussion of a possible alternative to VDL-3 is presented; this alternative includes a channel split to 8.33 kHz DSB-AM for increased voice capacity along with the use of VDL-2 for data link.

2. Consideration of a systematic implementation of VDL-3

2.1 As the year 2010 approaches, plans for a possible implementation of VDL-3 could be completed. An early implementation of VDL-3 in the post-2010 time period, it is assumed, would concentrate on voice communications. However, VDL-3 is designed to provide voice and data link communications to an aircraft in a functionally simultaneous manner on the same 25 kHz channel, using a single antenna and radio. The transition would need to be carried out in a phased approach, taking into consideration the equipage of the airspace users and the types of sectors to be implemented first. Initial testing must be completed to validate the performance of VDL-3 prior to any operational implementation.

2.2 It would be anticipated that commercial aircraft, and other aircraft that fly in the upper airspace, would be the first class of aircraft to be equipped with VDL-3. This stems in large part from the basic multi-mode radio design: that is, the same radio design (i.e., modulation, digital transmission rate, transmission power, etc.) used for VDL-2 data link would also be used for VDL-3. Thus, upper airspace users that would be beginning to equip to operate with VDL-2 data link in the post 2000 time period would be considered to be the first class of users to be able to operate with VDL-3. Assuming such an equipage, an initial transition to the use of VDL-3 would likely be in the high altitude enroute sectors.

2.3 There would not be sufficient spectrum available to provide access to both the present DSB-AM system and the VDL-3 system in the same airspace even in an early operational implementation of the VDL-3 system. Thus, all users in a sector implemented to operate on VDL-3 would need to have a radio equipped to operate with the new system capability. It is assumed that the airspace user flying in a VDL-3 sector

would have a multi-mode radio capable of operating on DSB-AM voice and VDL-3 voice. When a user tuned the radio to the channel identifier provided by the controller, the radio would automatically change to the appropriate voice mode (DSB-AM or VDL-3). In this manner, a user's flight into an upper airspace sector implemented with the new VDL-3 voice service would be functionally transparent to the pilot and controller (except for the new channel "numbering" for VDL-3).

2.4 The first phase of implementation, from the ground radio standpoint, would be based on studies to identify several high altitude sectors which might be serviced from the same ground location. (It should be noted, however, that a ground system transmission timing synchronization capability could allow other circuits on the same 25 kHz channel to be used at different ground locations in the same area.) An initial implementation might be to only replace one DSB-AM sector with VDL-3. In this case, only one-fourth of the VDL-3 capacity would be used. If the transition of that sector went smoothly, then another circuit of the same 25 kHz VDL-3 channel could be used to replace another DSB-AM sector that could be covered from the same location. In this case, one 25 kHz channel would be "freed-up" to be used elsewhere for a DSB-AM service, or to be used in the transition plan. At this point, only two circuits of the 25 kHz VDL-3 channel capacity would be used. The remaining two circuits could be used as a reserve, used to add additional voice services, or used later to provide data link to the two sectors provided with the digital voice service (e.g., one voice and one data link circuit in each sector).

2.5 A subsequent continuing transition to VDL-3 would extend to completing the implementation in the upper airspace, followed by selected low altitude sectors and terminal applications. Follow-on transition to data link applications would be possible. The extent and timetable of the VDL-3 transition would be the subject of future planning.

3. Consideration of the possibility of an alternative implementation

3.1 Another option for providing ATS A/G voice communications for the future would be to use the current DSB-AM technology, but with narrower channels 8.33 kHz wide. This "channel splitting" was used in the past to create more channels when additional spectrum resources were needed to satisfy a growing A/G frequency assignment requirement. The last such split (from 50 kHz to the current 25 kHz channels) was adopted in 1977. There were many reasons why the 8.33 kHz option was not selected as the future system candidate during the RTCA and ICAO studies of potential systems to satisfy future A/G voice communication requirements. It is not a digital-based implementation; thus, the 8.33 kHz option does not offer any new benefits, such as security, automated handoff, and other improvements that could increase the efficiency of the NAS.

3.2 In addition, many RCAG sites have the maximum number of transmitters possible, within the constraint of implementing good co-site engineering practices (i.e., ensuring that there will not be interference from many transmissions at one site). Therefore, the

implementation of 8.33 kHz, resulting in many more radio frequency channels (with one communications circuit per 8.33 kHz channel) than VDL-3 (with four communications circuits per 25 kHz channel), would likely require construction of additional RCAGs, at high cost, to achieve a capacity increase benefit.

3.3 Consideration of VDL-2 data link, to provide a data link capability to be used in conjunction with 8.33 kHz voice

3.3.1 The VDL-2 data link system was designed concurrently with VDL-3. The two systems reflect only minor hardware and software differences. This was done to have a high degree of commonality between the ATS and AOC equipment used on modern civil aircraft. VDL-2, however, was optimized for the long AOC type messages by creating a 25 kHz wide data channel for high data rates. In contrast, VDL-3 was optimized for the typically short ATS messages, and each 25 kHz radio frequency channel was split into four independent communication circuits which could be used to simultaneously satisfy the requirements of any mix of up to four voice and/or data link circuits.

3.3.2 AOC messages, by nature, are a single priority. That is, they can be accommodated on a "first-come, first-served" basis. ATS messages, however, come in a variety of priorities. For example, time critical ATS messages include distress and emergency messages. Non-time critical ATS messages include some types of weather advisories and routine clearance messages. Therefore, one of the requirements of the ATS A/G communications system is the capability to prioritize the messages awaiting transmission, and, if necessary, preempt a transmission in progress to immediately transmit a higher priority message. VDL-2 does not have this capability, and thus is limited to sending non-time critical messages.

3.3.3 In addition, the design of VDL-2 reflects a probabilistic design for the transmission of messages, which does not preclude the transmission of messages from different locations during the same time period. This leads to "message collisions", resulting in message transmission delays (which is a result of the time that it takes the system to recognize that the messages have not arrived at their destination, and until the affected messages can be resent and received). In contrast, VDL-3 has been designed from the outset to provide a deterministic means of ensuring the transmission and arrival of messages, in which, to the highest degree possible, the communication delays can be systematically determined.

4. Concerns linked to early implementation of ATS data link communications

4.1 As an interim step towards integrating data link into the ATS communications system, the FAA had decided to initially implement a non-time critical subset of CPDLC messages via a service provider using VDL-2. (After an implementation of VDL-3, it is assumed that these CPDLC messages would be transmitted via the VDL-3 system.) While the service provider claimed to be able to satisfy all known ATS data message delivery requirements, by using the excess capacity of the newly implemented VDL-2

system, there are several spectrum issues that must be addressed. As more CPDLC messages are added to VDL-2, there would likely be additional FAA requirements for latency (message delivery time) and availability. There was a concern that the service provider had not taken into account those new requirements when determining the capability of and the spectrum needs for the AOC messaging system. CPDLC trials have been conducted in Miami, Florida.

4.2 The AOC VDL-2 data messaging capability operates on AOC channels, and not on ATC channels.

References for Appendix 1.2

A1.2-1 "A Study of the Potential Benefits to be Derived from the 23 (Plus 2) VHF Air Ground (A/G) Communications Improvement Measures", by ATO-W ATC Spectrum Engineering Services, September 2001.

References for Section 1

1.1 "FAA Aerospace Forecasts, Fiscal Years 2003-2014", FAA-APO-03-1, March 2003.

1.2 "Assessment of Radio Spectrum Depletion on ATC Voice Communications", by ATO-W ATC Spectrum Engineering Services, September 2003.

1.3 "Recommendations of the NEXCOM Aviation Rulemaking Committee to the Federal Aviation Administration", September 2001.

Section 6 - Navigation Requirements

6.1 Introduction

6.1.1 The navigation capability forms a critical part of the communications, navigation, and surveillance triad that allows air traffic control to operate in a safe and efficient manner within the NAS. Typically, the pilot is issued an airspace clearance via A/G communications to fly a specific route and altitude profile. The pilot is responsible for ensuring that his/her aircraft follows the clearance instructions using the appropriate aeronautical radionavigation system capabilities available in the NAS. (In contrast, surveillance is the capability that is used to check on the progress of the aircraft to help ensure, inter alia, that the aircraft is following the clearance instructions and not deviating into a potentially dangerous situation.) Thus, it is clear that the navigation function plays a very important role in the NAS. It should be noted that there are aircraft self-contained navigation systems, specifically the Inertial Navigation System (INS); however, most of the navigation services provided in the NAS are via radio systems operating within the Aeronautical Radionavigation Service (ARNS).

6.1.2 The need for better accuracy, capabilities for new applications, and an increased area of coverage has resulted in the implementation of a large number of navigation systems requiring a significant amount of radio frequency spectrum. In addition, because of the critical nature of the navigation services, their operation is dependent on the availability of interference free radio spectrum. It should be noted that, in contrast to communications systems, navigation systems have various degrees of monitoring to help protect navigation services from harmful and misleading information. There is a continuing pressure for more and newer ARNS systems at many airports within the NAS. While ATO-W is doing its utmost to help satisfy the continued demand for navigation services, without analysis it is not clear whether sufficient radio spectrum resources exist to satisfy all the new requirements. This navigation system spectrum plan is a support element of the FAA's CIP, Flight Plan 2004-2009, and OEP. In addition, this plan is consistent with the 2001 Federal Radionavigation Plan (FRP), which projects that the systems addressed in this plan will remain operational for an extended, post 2010, time period to satisfy foreseen requirements (see Ref. 6.1, Figure 3-1).

6.2 Purpose

6.2.1 The purpose of this plan is to ensure, to the extent possible, that the future spectrum requirements for ARNS system implementations to the year 2010 can be satisfied.

6.3 Background

6.3.1 Over the past half century, the implementation of a broad system of ARNS installations has been carried out to satisfy enroute, terminal, non-precision approach, and precision approach requirements. This implementation has required a significant amount of radio spectrum resources in a number of frequency bands across the spectrum. Factors relating to the amount of radio frequency spectrum needed include the number of systems to be implemented and the required frequency engineering criteria. The frequency engineering criteria is a complex set of parameters determining how close stations on the same channel or adjacent channels can be placed geographically to prevent Radio Frequency Interference (RFI) either between themselves or from other systems.

6.3.2 The geographic area for which the radio service from each navigation facility is protected is called the Frequency Protected Service Volume (FPSV). In order to extend the coverage of facilities, Expanded Service Volumes (ESVs) are established in many cases using specific frequency engineering criteria. It should be noted that all established air routes, including random air navigation (RNAV) routes, must be within the FPSVs engineered for the facility or facilities being used to service the routes.

6.3.3 The worldwide interoperability requirement for ARNS systems is satisfied by requiring that the system standards and frequency engineering criteria are consistent with ICAO SARPs. In addition, the navigation systems must conform to U.S. regulations, including NTIA, FCC, and FAA regulations, technical standards, and service requirements, as appropriate.

6.3.4 It is becoming increasingly difficult to satisfy the future requirements to implement additional facilities for existing navigation systems and the new navigation systems with the limited amount of available radio frequency spectrum. Many of the new system capabilities must be squeezed into radio frequency spectrum that is already being used by existing systems. New systems include the Global Positioning System (GPS) civil signal capabilities (L5), the GPS Wide Area Augmentation System (WAAS), the GPS Local Area Augmentation System (LAAS), the Universal Access Transceiver (UAT), and the Transponder Landing System (TLS). Further, spectrum management issues exist, as highlighted in the next section, that impact facility or system implementation. Thus, it is extremely important to closely manage the remaining spectrum resources.

6.4 ARNS spectrum management issues, future requirements, and the satisfaction of future requirements

6.4.1 Introduction

6.4.1.1 The spectrum management issues, future requirements, and the satisfaction of future requirements are presented, to the extent possible, on a frequency band basis, starting from the lowest frequency band used by ARNS facilities. The study included the consideration of the following ARNS systems and system elements:

1. Non-Directional Beacon (NDB)
2. Instrument Landing System (ILS) Marker Beacons
3. ILS Localizer
4. VHF Omni-directional Range (VOR)
5. VOR Test (VOT) Facilities
6. Ramp Testers
7. Local Area Augmentation System (LAAS)
8. Special Category One System (SCAT-1)
9. Transponder Landing System (TLS)
10. VDL Mode 4 (VDL-4)
11. ILS Glideslope
12. Distance Measuring Equipment (DME)
13. Tactical Air Navigation (TACAN) System
14. Universal Access Transceiver (UAT)
15. Global Positioning System (GPS)
16. Wide Area Augmentation System (WAAS)
17. Microwave Landing System (MLS)

6.4.1.2 The statement of navigation service requirements to the year 2010 are still evolving. Those requirements that are known to date will be highlighted in this section. A consideration of whether these known requirements can be satisfied are based on the results of frequency engineering carried out to date, and a projection, if possible, on whether it is believed that there are sufficient spectrum resources available to satisfy any requirements that have not been frequency engineered to date.

6.4.1.3 From a spectrum management viewpoint, the primary focus on satisfying new navigation service requirements is whether sufficient spectrum is available to make frequency assignments to allow specific facilities or systems to satisfy the intended navigation service requirements (including the locations and service volumes). Thus, the future navigation service requirements will be examined from a navigation system standpoint, rather than from whether the requirement is an enroute, terminal, non-precision approach, or precision approach service requirement.

6.4.2 190-535 kHz NDB band

6.4.2.1 Frequency assignment congestion: There are a large number of civil aviation beacons assigned in the available spectrum, thus it is very difficult to make new frequency assignments. There are approximately 2247 NDB frequency assignments in this band, of which the majority, 1523, are non-FAA assignments.

6.4.2.2 Voice quality: Many NDBs are presently used as voice outlets for AWOS, ASOS, and other broadcast services. However, it is difficult to obtain adequate voice quality using an NDB. A contributing factor is the narrow bandwidth of the transmitting antenna, which can distort the voice signal. NDB voice is also susceptible to a significant amount of noise, which is inherent to the NDB frequency band. In addition, the use of voice on NDBs reduces the amount of spectrum available for NDB navigation services, since a greater bandwidth is required to provide NDB voice services.

6.4.2.3 Longevity of NDBs: Many of the FAA supported NDBs have been operational for many years. While these systems continue to age, the potential of new systems, in particular GPS, have led planners to believe that in the very near future NDBs may be able to be decommissioned. However, based on the number of frequency assignment requests, in particular non-Federal, there is a continuing need for the present system of navigational aids (in particular, NDBs are needed in Alaska to provide weather information, in addition to the navigation capability).

6.4.2.4 Expansion of maritime differential GPS facilities: The maritime community uses radio beacons as a source for disseminating differential GPS information to users within the coverage areas of the beacons. This service is implemented in a maritime portion of the frequency band, where some FAA NDBs are implemented. The expansion of this maritime differential GPS service has required the FAA to move NDBs out of the maritime portion of the band, resulting in increased frequency assignment congestion.

6.4.2.5 Future NDB requirements and spectrum availability: The future requirement for NDBs is anticipated to be mostly for non-Federal systems. However, some new ILS installations may have compass locator beacons associated with outer markers beacons (known as LOMs, an NDB service) associated with them. In summary, a significant future NDB requirement is not expected, and, thus, it is considered that there will be sufficient spectrum resources available to satisfy the new NDB requirements.

6.4.3 75 MHz marker band

6.4.3.1 There is a single frequency channel at 75 MHz serving ILS outer, middle, and inner marker beacons, whose purpose is to alert the pilot (via a receiver on the aircraft) of his/her progress along an ILS approach. There are approximately 1544 FAA and 143 non-FAA marker beacon frequency assignments on this frequency.

6.4.3.2 Use of marker frequency for runway incursion prevention: The FAA is considering the use of the marker beacon receiver capability on the aircraft for runway incursion prevention. In such use, a low power marker beacon-like signal will be transmitted at key points in the runway/taxiway system to alert pilots when they are about to enter/exit certain points. Care must be exercised to ensure that such usage would not interfere with the present marker beacon function.

6.4.3.3 Future marker requirements and spectrum availability: The future requirement for Marker facilities will be largely consistent with the implementation of ILSs, since the marker beacon transmitter is an element of the ILS. It is not anticipated that there will be any problems satisfying the future requirements for marker beacon implementation. It is also expected that a possible future requirement for the use of marker beacon capabilities for runway incursion prevention could also be accommodated on this frequency.

6.4.4 108-118 MHz ILS/VOR band

6.4.4.1 Frequency assignment congestion: Frequency assignment congestion is the number one spectrum management issue with both the ILS localizer and the VOR. This stems from the sizable number of systems that operate, or are planned to operate, in the 108-118 MHz band. The present systems include the ILS localizer, VOR, and SCAT-1 systems. There are approximately 1179 FAA and 401 non-FAA ILS localizer frequency assignments, and 982 FAA and 110 non-FAA VOR frequency assignments in this band. In addition, possible new systems include the LAAS, TLS, and VDL-4. Consideration has also been given to the possible future implementation of VHF A/G communications in the upper portion of the band (see 6.4.4.12 and 6.4.4.13). The congestion stems from two aspects, the large number of service requirements and the difficulty posed by the RFI potential of nearby high power frequency modulation (FM) broadcast stations operating in the adjacent 88-108 MHz band (in particular to localizers that operate in the lower, 108-112 MHz, part of the band).

6.4.4.1.1 A number of initiatives were undertaken over the years to reduce the frequency congestion in the 108-118 MHz band. In the latter 1970s, both the ILS localizer and VOR services introduced 50 kHz channel spacing (previously 100 kHz). However, general aviation did not transition in a timely manner to the new 50 kHz spacing, and even today many general aviation users can only use 100 kHz channels. Other initiatives included reducing the standard service volume for ILS localizer coverage from 25 NM to 18 NM, and using the same frequency (instead of separate frequencies) for “back to back” localizer assignments (i.e., for two localizers serving the opposite approaches to the same runway). The FAA also planned to implement MLS, thereby freeing up spectrum in the 108-112 MHz band segment; however, the FAA decided in the mid-1990s not to implement MLS in favor of new services supported by GPS.

6.4.4.2 FM broadcast interference to VOR and ILS localizer operations: Both the ILS localizer and VOR frequency bands begin at 108 MHz, the upper edge of the FM broadcast band. The presence of many high power FM stations adjacent in frequency to VOR and ILS localizer operations increases the chance of interference to these navigation services. Interference is due to two primary causes. Desensitization of the navigation receivers occurs due to the brute force power of high power FM stations operating near to the 108 MHz band edge. In addition, FM signals can mix in the front end of VOR and ILS localizer receivers, resulting in the generation of a new signal that falls within the channel bandwidth of the desired navigation signal, thereby potentially providing misleading guidance to the pilot.

6.4.4.2.1 Under the Federal Air Regulations, Part 77 Airspace Process regulatory framework, any broadcasting service intending to change its present operation, or any new prospective broadcasting service, must file an advance plan with the FAA detailing such characteristics as the proposed transmitted power, antenna pattern, antenna height, etc. This process provides the information and time for the FAA to analyze the modified or new operation, to determine if there would be any potential for interference to ILS or VOR services, and to coordinate with the broadcast service and the FCC regarding the findings.

6.4.4.3 ICAO FM immunity requirements (FM immunity): In the latter 1980s and 1990s, ICAO, with U.S. participation, worked extensively on the development of new FM immunity standards to help ensure that ILS localizer and VOR operations would be free from interference from FM broadcast stations. Those international standards have been in force for several years. However, the United States has not adopted these ICAO standards, and has filed an exception to the use of the new ICAO FM immunity standards. This action was taken as a result of recommendations made by the Aviation Rulemaking Advisory Committee (ARAC), which includes Government and industry representatives. In order not to require the equipage of new receivers in the large population of general aviation aircraft, at great cost, it was decided by the ARAC to continue to protect the older radio receivers by using existing criteria. Thus, the FAA continues to protect radio receivers that do not satisfy the ICAO immunity requirements.

6.4.4.4 Localizer and VOR ESVs: While there is a very high level of frequency assignment congestion being experienced for new or modified localizer and VOR services, it is even more difficult to satisfy requests for ESV coverage for these navigational aids. In particular, localizer and VOR coverage areas that might have been established by very careful engineering, perhaps with changes in the service volumes or frequencies of nearby navigational aids, are nearly impossible to expand using the ESV criteria.

6.4.4.5 LAAS operations in VOR band: There is a continuing frequency assignment problem for VORs in the 112-118 MHz sub-band. In addition, it is planned that the new LAAS capability will also operate in this sub-band in the NAS. Until there is a meaningful de-commissioning of at least some VORs, it may be difficult to implement LAAS installations in this band beyond the present plan of 161 stations. Further compounding the problem, LAAS frequency assignments are being limited to below 117.2 MHz to protect the VHF A/G communications in the adjacent band (118-137 MHz) from LAAS emissions.

6.4.4.6 LAAS standardized down to 108 MHz: While it is the intention to initially implement LAAS in the NAS in the 112-118 MHz sub-band, this system capability has been standardized by ICAO to operate in the 108-118 MHz band. The possible implementation of LAAS installations in nearby Canadian and Mexican border areas, in the 108-112 MHz sub-band, could impact the present ILS localizer installations in the NAS.

6.4.4.7 ILS localizer system interlock issue: In order to be able to conduct routine maintenance with the localizer transmitting, it is desired to have the localizers at the ends of the same runway transmit on different channels. However, due to the severe frequency congestion, in many cases both localizers have been assigned the same channel. This has caused a significant localizer maintenance issue, since maintenance technicians cannot routinely allow the non-operational localizer to transmit when maintenance checks are needed. It is thus necessary to conduct maintenance at off peak hours, when maintenance is not routinely conducted.

6.4.4.8 Aircraft without 50 kHz channel capability: Some aircraft that routinely fly into airports requiring ILS localizer operations are not equipped with 50 kHz (200 channel) receivers. Thus, it is necessary to try and find (and continue to operate) ILS localizer channels that fall on a 100 kHz center in such cases. This restriction compounds the frequency congestion situation, and sometimes limits the ability of the FAA to change channels to satisfy new nearby ILS requirements.

6.4.4.9 Two sets of receiver protection criteria: While the ILS/VOR channelization was changed from 100 kHz to 50 kHz channels in the late 1970s, the FAA has continued to protect the operation of the many thousands of general aviation and DOD 100 kHz ILS/VOR receivers still in operation (i.e., receivers that only tune to the 100 kHz channels and have a wider, less stringent, receiver bandwidth). The protection of 100 kHz receivers has required the use of two sets of frequency assignment criteria, "interim"

and "final". The less spectrum efficient "interim" criteria must still be applied to protect the 100 kHz channel assignments. The FAA will need to continue to use this criteria until users transition to 50 kHz receivers.

6.4.4.10 VDL-4 operations in 108-118 MHz band: ICAO has assigned the VDL-4 to operate within the 118-137 MHz band; operation is also allowed in the 108-118 MHz band. The developers foresee a need for a number of channels, including several in the 108-118 MHz band. The intent seems to be toward reserving a number of 25 kHz channels for VDL-4 operations on a worldwide basis. Because of the severe frequency assignment congestion, it would be very difficult, if not impossible, to find a channel for VDL-4 operations in the NAS. However, as a result of the Automatic Dependent Surveillance-Broadcast (ADS-B) link decision process, the FAA has decided not to implement VDL-4 in the NAS.

6.4.4.11 Ramp test frequencies: Designated frequencies have been established for normal ramp testing (VOR at 108.00 MHz and 108.05 MHz, and ILS localizer at 108.1 MHz and 108.15 MHz). Since many FM broadcast stations operate close in geographic proximity to the test stations, the FAA has had to provide test frequencies from operational channels higher in the band to avoid the potential for interference to the test facilities from the FM stations. Careful coordination is required to ensure that these non-typical test frequencies do not cause interference to operational ILS services.

6.4.4.12 Possible expansion of VHF communications into the 112-118 MHz band: There is such a pressure to find additional spectrum resources to satisfy the varied and large requirements for VHF A/G communication services (that presently operate in the 118-137 MHz band), that consideration has also been given in ICAO to expanding some of the A/G communication services into the 112-118 MHz band. One possibility is to move the band edge down one or several MHz from the present 118 MHz band edge.

6.4.4.13 Possible VHF ground-to-air broadcast communications in 112-118 MHz band: One of the improvement initiatives in the VHF A/G communications spectrum management plan is the possible use of VOR channels (not VOR transmitters) for ground-to-aircraft (one way) broadcast services, such as AWOS or ASOS. The signals, originating from a VHF communications transmitter on the ground, would be received on the aircraft by VOR receivers. Such a service would allow the user community to use, in a limited way, possible spectrum resources outside the 118-137 MHz band for A/G communication services without re-equipping with new radios.

6.4.4.14 Future ILS localizer requirements and spectrum availability: The ILS localizer requirements for new installations presented in [Figure 6.1](#) have been obtained from the FAA's OEP and from ATO-W Navigation Services on Congressionally mandated ILS installations through FY-2005 (Congressionally mandated ILS requirements have not been received for the following years).

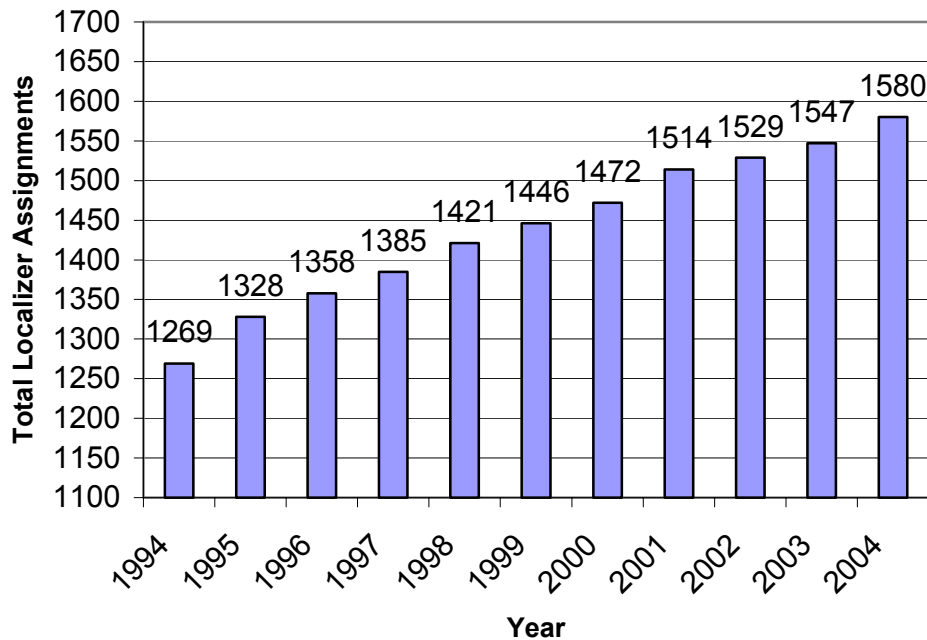
Figure 6.1**Future ILS New System Requirements**

FY	<u>2005</u>	<u>2006</u>	<u>2007</u>	<u>2008</u>	
OEP	4	4	2	2	(engineering completed)
Nav¹	25 (engineering to be completed for these ILS systems, which include Congressionally mandated requirements)				

Notes: 1. Nav = ATO-W Navigation Services

6.4.4.14.1 It is judged that there will be sufficient spectrum resources available to make the remaining frequency assignments for the 2005 requirements. Spectrum resources are expected to be available to implement some additional ILS systems in lower traffic density areas of CONUS. However, it would be extremely difficult, perhaps impossible, to make further ILS frequency assignments in some high traffic density areas, such as the New York City area. It is expected that there will be additional ILS implementation requirements for the years after FY-2005 (i.e., beyond those identified in [Figure 6.1](#)). This stems from the history of new ILS frequency assignments over the years. [Figure 6.2](#) shows that there has been an average of over 25 new frequency assignments a year from 1994 thru 2004 (including FAA, DOD, and other Government and non-Government requirements). While the number of new assignments has decreased slightly for some recent years, the average has still been over 25 new frequency assignments a year through the 2000-2004 time period.

Figure 6.2
Growth of ILS Localizer Frequency Assignments
in the United States



6.4.4.14.2 If the historical requirement for new ILS (with DME) systems continues at the present rate, the frequency requirements for them will not be able to be satisfied at many locations. Thus, action needs to be taken at the earliest possible date if the life of the ILS system is to be extended.

6.4.4.14.3 One improvement could be to pursue requiring the user community to equip with 50 kHz channel receivers, possibly adhering to the new ICAO immunity standards (see also Section 6.4.4.9). For such a requirement to be acceptable to the user community, several years would need to be given to re-equip; specific details would need to be defined as part of a related rulemaking determination. Thus, consideration of this measure would need to be taken at the earliest date possible. Other improvement possibilities will also need to be investigated.

6.4.4.15 Future VOR requirements and spectrum availability: It is projected that there will be very few new VOR requirements. The new requirements will include some service upgrades (i.e., an increase in service volumes). Even so, there may not be

sufficient spectrum to satisfy new VOR requirements, especially for implementation in high traffic density areas. One system improvement would be for users to have 50 kHz aircraft receivers (see Sections 6.4.4.9 and 6.4.4.14.3).

6.4.4.16 Future LAAS requirements and spectrum availability: The present LAAS implementation plan (1999 FAA Requirements, Appendix B, LAAS Installation Locations, Revision 1, 2/8/2002) projects an implementation of 161 systems. Spectrum engineering carried out to date has identified sufficient spectrum resources above 112 MHz to satisfy these requirements, based on the following assumptions: (1) only one transmitter at one site, using two time slots of the eight time slots available on a single 25 kHz frequency channel, would be required at each airport; and (2) a service altitude and distance no greater than 20,000 feet and 23 NM, respectively. If a larger coverage area, or additional transmitters and/or additional time slots would be needed to satisfy the navigation requirements for any of the airports analyzed, then the results of the analysis may not be valid.

6.4.4.17 Future SCAT-1 requirements and spectrum availability: No new installations of this non-Federal Special (i.e., non-public use only) Category I precision approach GPS-aided system are expected.

6.4.4.18 Future VDL-4 requirements and spectrum availability: As a result of the ADS-B link decision, the FAA has decided not to implement VDL-4 in the NAS (See Section 6.4.4.10 above)

6.4.4.19 Future TLS requirements and spectrum availability: This is a Special Use Only (i.e., non-public use only) non-Federal system, that allows one aircraft at a time to conduct precision approach operations. It will require frequency assignments on both ILS localizer and glideslope frequency channels, as well as use of the 1030/1090 MHz Secondary Surveillance Radar (SSR) beacon band. Based upon inputs from a Congressionally mandated program on TLS, it is projected that only about 15 TLS systems might be implemented in the United States. Frequency engineering has been completed on several test bed TLS systems to date.

6.4.5 328.6-335.4 MHz ILS glideslope band

6.4.5.1 The ILS glideslope operations are implemented in the 328.6-335.4 MHz ARNS band. There are approximately 1058 FAA and 276 non-FAA ILS glideslope frequency assignments in this band.

6.4.5.2 Future ILS glideslope requirements and spectrum availability: One glideslope will be required for each localizer to complete an ILS installation. Except for the lack of potential interference from FM broadcast stations, a similar frequency congestion problem exists for ILS glideslopes as for localizers. Since the spectrum congestion is greater for ILS localizer operations, it is assumed that if an ILS localizer can be implemented, it will be possible to implement the associated glideslope as well.

6.4.6 960-1215 MHz DME/TACAN band

6.4.6.1 Frequency congestion: There is severe frequency assignment congestion in the 960-1215 MHz band, as a consequence of the many DME and TACAN operations in this band, and two SSR channels centered at 1030 MHz and 1090 MHz (where 20 MHz and 11 MHz, respectively, are protected for these channels). (The use of the SSR system will be documented in the surveillance section of this report.) There are approximately 828 FAA and 155 non-FAA DME frequency assignments, and 614 FAA and 31 non-FAA TACAN frequency assignments in the 960-1215 MHz band. As a result of the frequency congestion, it is very difficult to implement new DME/TACAN operations in this band. In addition, the new GPS L5 civil signal and the UAT are planned to operate in this band.

6.4.6.2 GPS L5: A new worldwide frequency allocation was obtained at the 2000 World Radiocommunication Conference to support the new GPS civil aviation signal, called L5. L5 will be included in the new generation of the GPS, in addition to the present L1 civil signal, with initial operational capability (IOC) scheduled for 2013. L5 is planned to operate in the TACAN/DME band at a center frequency of 1176.45 MHz (it should be noted that L1 transmits at a 1 MHz bit rate, while the new L5 signal will transmit at a 10 MHz bit rate). Co-frequency (and nearby frequency) transmissions from ground DME transponders and the Joint Tactical Information Distribution System/Multifunctional Information Distribution System (JTIDS/MIDS) were identified as having a potential to interfere with L5 signal reception on aircraft. It was determined that, depending upon the density of DME and TACAN implementation within a geographic area, DME and TACAN frequency assignments on the center frequency and up to 9 MHz on either side of 1176.45 MHz might need to be changed to protect L5 reception in aircraft at high altitude (see Section 6.4.6.2.2 below).

6.4.6.2.1 In order to make the GPS L5 civil signal more tolerant of interference, including allowing it to operate in areas with a low implementation density of DMEs and TACANs without requiring any DME and TACAN frequency assignment changes, the L5 signal had been planned to be 6 dB higher in power than the present L1 GPS signal. However, the present design provides for only a signal level 5.1 dB above the present L1 signal (i.e., 0.9 dB weaker than planned), at least for the initial implementation of satellites. This will impact the ability of the signal to coexist in its intended environment.

6.4.6.2.2 Based on the present L5 system design characteristics, ATO-W ATC Spectrum Engineering Services conducted a study (Ref. 6.2) to determine what changes might need to be made to the DME and TACAN frequency assignments to protect L5. It was determined that the protection of L5 might require up to 70 DME and TACAN frequency assignments to be moved out of the band segment in which L5 would operate. Subsequently, in 2004, the results of a refined analysis by RTCA determined that it would be possible to lower the L5 signal acquisition threshold, thereby eliminating the need to move DME and TACAN frequency assignments to protect future L5 operations (Ref. 6.3).

6.4.6.2.3 It should be noted that a complicating factor of having to move DME and TACAN frequency assignments would have been that many DME and TACAN operations are coupled (from a frequency channel usage standpoint) with VOR operations, thus also requiring many VOR frequency assignment changes. However, the VOR frequency assignment changes couldn't be made without assuming a change in the VOR frequency engineering criteria (which would have required all users to have 50 kHz VOR receivers...ICAO standards has specified the carriage of 50 kHz receivers since the early 1990s).

6.4.6.3 UAT operation on DME ramp tester channel: The UAT, an ADS-B alternative, operates on a center frequency of 978 MHz, with a 1 MHz bandwidth. This is a DME and TACAN ramp test frequency in the United States (a survey has revealed that there are only a few (7) operational DMEs and TACANs in the world on 978 MHz). Studies and tests have been conducted that indicate that there will be no mutual interference between ramp testers and UAT elements operating on this channel under the level of UAT operations assumed in the studies and testing. From an integrity standpoint, no potential for interference has surfaced (each of the systems (UAT and DME) have significantly different pulse/data coding techniques). However, a mobile, non-aircraft UAT operational component might be developed which may have the potential to cause interference to DME ramp testing, and care will be needed in the placement of the ground-fixed portion of the UAT system to also ensure that there will be no interference to DME ramp testing. It is expected that UAT ICAO SARPs will be approved in 2005.

6.4.6.4 Directional DME antenna problem: Because of the high degree of frequency assignment congestion, the use of directional DME antennas has been introduced. The directivity of the antennas allow for a DME service to be implemented where it would otherwise not be allowed (the broader DME service coverage provided with a conventional omni-directional coverage antenna would cause interference to adjacent DME frequency assignments already implemented). However, the limited coverage provided by the directional antennas may lead to operational usage problems, stemming from, for example, the limited ATC routing that can be supported (and a loss of flexibility in changing ATC routing). In addition, users sometimes assume that the DME coverage is omni-directional, when it is not, thereby resulting in user complaints of poor reception.

6.4.6.5 Narrow band antennas on older TACANs: Older TACAN antennas are either high band or low band in the frequency range that they can support. Thus, flexibility is limited with these systems with regard to changing frequencies, which may be necessary to implement new systems.

6.4.6.6 Department of Transportation(DOT)/DOD Memorandum of Understanding: DOD JTIDS/MIDS operations are allowed in the 960-1215 MHz band on a non-interference basis. A memorandum of understanding (MOU) has been implemented between DOT and DOD that will allow greater technical and operational compatibility between civil aviation systems (e.g., DME, UAT, and L5) and JTIDS/MIDS. This MOU,

among other things, requires JTIDS/MIDS to have the capability to inhibit transmissions on select frequencies in the 960-1215 MHz band, in order to protect future civil systems planned to operate below 1030 MHz.

6.4.6.7 Future DME requirements and spectrum availability: The known new DME requirements (i.e., new installations requiring the engineering of new frequency assignments) are presented below in Figure 6.3.

Figure 6.3 New DME System Requirements

<u>FY</u>	<u>2005</u>	<u>2006</u>	<u>2007</u>	<u>2008</u>
OEP¹	3	4	2	2
Nav^{2,3}	22	22	22	22
Nav²	25 (engineering to be completed for these DME systems, which include Congressionally mandated ILS requirements)			

Notes: 1. Engineering for these DMEs associated with OEP ILS installations have been completed.
2. Nav = ATO-W Navigation Services.
3. Engineering for these DMEs associated with Control Flight Into Terrain program requirements, as developed by the Civil Aviation Safety Team (CAST), have been completed.

6.4.6.7.1 Except for the 25 outstanding DME systems to be engineered, the frequency engineering has been completed for all the known DME requirements (see Figure 6.3). The DME frequency congestion problem impacts the implementation of ILSs, since a DME is associated with many of these systems. While directional DME antennas may cause some problems (see above), their use is one means of alleviating the ILS related problem. This alternative has not been used significantly to date.

6.4.6.7.2 A new program has been initiated to implement DME-DME RNAV routes (including quick (Q) routes for enroute operations, and standard arrival (STAR) and standard instrument departure (SID) routes for terminal operations). These initiatives consist of expanding the FPSVs of current installations to support the new operations.

6.4.6.7.3 Currently, there are also 20 DME NAS channels being used by the DOD for air-air refueling. While the DOD has indicated that these DME channels are presently needed to support the air-air refueling function, the potential for regaining at least some of these channels in the future for NAS operations should be investigated.

6.4.6.8 Future TACAN requirements and spectrum availability: It is projected that there will be very few new TACAN requirements. Sufficient spectrum should be available to satisfy any new TACAN requirements.

6.4.6.9 UAT requirements and spectrum availability: As highlighted above, no interference from aircraft is anticipated from the operation of the UAT on the single channel (centered on 978 MHz) for which it is designed to operate. However, with the possibility of non-aircraft mobile users of UAT, and the need to ensure that the fixed-ground element of the UAT is suitably sited to prevent interference to the DME ramp testing, frequency assignment criteria and possible operational constraints will need to be carefully developed. Unless a new channel is required, which has not been postulated, there is no foreseen future requirement problem.

6.4.7 1559-1610 MHz GPS/WAAS band

6.4.7.1 The 1559-1610 MHz band will need to be protected in the future for the exclusive use of present and evolving future Radio Navigation Satellite Services and ARNS such as pseudolites. The GPS L1 civil aviation signal is transmitted in this band from satellites on a center frequency of 1575.42 MHz. While the pseudo random noise (PRN) coded signal is only transmitted at a 1 MHz bit rate, the protection of a significantly larger bandwidth is required to ensure adequate reception of the signal information and also to mitigate multipath interference. The WAAS satellites also transmit on the L1 signal format on the same center frequency. It should be noted that GLONASS (the Russian satellite navigation system) also operates in the 1559-1610 MHz band.

6.4.7.2 Future compatibility between GPS and the proposed European Galileo satellite navigation system: Europe is designing a new satellite navigation system called Galileo, that will operate in the 1559-1610 MHz band. A binary offset code transmission format, which would interleave with the GPS signals in the same band, has been proposed. This evolving design will have to be reviewed carefully to ensure that there will be no interference to GPS.

6.4.7.3 Future GPS requirements and spectrum availability: No future spectrum requirement problem is foreseen regarding the GPS L1 civil signal, since it is a worldwide, non-saturating system (i.e., the number of users does not have any impact on the spectrum required for the service). Thus, it does not require any further frequency assignments. Likewise, the WAAS satellites operate on the same L1 frequency assignment as GPS, and, therefore, no future requirement issue is foreseen. Ground-based pseudolites, also transmitting on the L1 frequency, but with a pulsed, wideband format to preclude interference (near-far problem), may be a system component in GPS-aided approach and landing systems in a future architecture.

6.4.8 5000-5150 MHz band

6.4.8.1 Operational MLS systems in the United States: There are still a small number of civil MLS systems in the NAS, and a sizable number of DOD operational MLS systems, which operate in the 5030-5091 MHz portion of this band. The DOD implementation consists of approximately 50 DOD MLS systems (approximately 35 Mobile MLSs (MMLS) and 15 Fixed Base MLSs (FBMLS)). A small number of FAA-owned FBMLSs are also being used by the DOD. Additional DOD MMLSs may also be implemented. These systems must be protected for operational usage. There are continuing pressures from industry to gain some degree of usage of the frequency band segment designated for MLS expansion (5091-5150 MHz). The FAA must continue to protect this band for future aeronautical applications such as MLS Category III at international airports. The ICAO standardized band (5030-5091 MHz) has not yet been challenged.

6.4.8.2 Potential requirement for new airport wireless local area network in 5000-5150 MHz band: In addition to protecting the 5030-5091 MHz portion of the band for MLS operations, there is a potential new requirement for an airport wireless local area network, called Airport Network and Location Equipment (ANLE), which would operate in the broader 5091-5150 MHz band, and would include both aircraft-ground and ground-ground communication links. The objectives of ANLE would be to provide more information to the pilot/cockpit and reduce runway incursions. The International Air Transport Association (IATA) has developed a system concept, called Airport Vehicle Position System, which is aimed at a system implementation of the ANLE functions, and would operate within the 5000-5150 MHz band. Therefore, the entire 5000-5150 MHz band needs to be protected for future ARNS usage.

6.4.8.3 Fixed links in 5090-5150 MHz: The FAA is facing a future crisis in the lack of adequate spectrum to satisfy the continuing need for point-to-point and point-to-multipoint communication links for transferring air traffic control related information. Thus, the FAA is developing a proposal to use a portion of the 5090-5150 MHz band to satisfy such future communications needs. A channel design structure similar to that of the 900 MHz band is being considered.

6.4.8.4 Future MLS requirements and spectrum availability: While the present MLS operational systems must be protected, there are presently no plans for the implementation of new MLS systems in the NAS.

6.4.9 Ultra wideband issue: A new initiative, approved by the FCC despite the strong concerns expressed by the Department of Transportation, the DOD, and the National Aeronautics and Space Administration, allows very wideband low power signals (known as ultra wideband (UWB)) to be transmitted throughout the frequency spectrum below 960 MHz and above 1.9 GHz as FCC Part 15 devices. The FAA will need to carefully follow the development of these systems to ensure that it will not cause RFI to the civil aviation navigation systems operating in all the ARNS bands.

6.4.10 Loran C not in properly protected band: Loran C operates within the frequency range of 90-110 kHz, in a band not allocated to the ARNS. The FAA is considering the use of Loran C in a future NAS navigation system mix. ATO-W will have to work carefully within the FAA to ensure that any evolving future mix of civil aviation navigation systems, which may include Loran C, will be afforded adequate protection from RFI.

6.4.11 Associated requirements: It should be noted that a number of ARNS facilities also require radio frequency spectrum in addition to that which is required to communicate with the aircraft. As examples, the WAAS requires fixed satellite service radio links for the ground-to-satellite links, the WAAS/LAAS requires the use of the GPS DOD signal (L2, for ground station usage), and the LAAS and TLS may require ground-to-ground radio links to satisfy stringent system interconnection requirements. At the present time, the satisfaction of these requirements has not posed a problem with respect to satisfying future navigation service requirements.

6.5 Summary and conclusions

6.5.1 A total of 17 present, future, and potential future navigation systems were examined in this report (see Section 6.4.1.1). A number of spectrum management issues that do or may have an impact on the satisfaction of future navigation system spectrum requirements were addressed. Finally, the evolving navigation spectrum requirements to the year 2010, to the extent they are known, were highlighted, along with the results of spectrum engineering work aimed at satisfying these requirements.

6.5.2 It will be very difficult to satisfy a substantial number of new requirements for the ILS, VOR, and DME systems in, in particular, the higher traffic density areas of the NAS, due to existing frequency assignment congestion. Locations now exist where it may not be possible to implement new ILS installations. If the historical requirement for 15 or more new ILS (with DME) systems continues each year, the frequency requirements for them will not be able to be satisfied at many locations.

6.5.3 Thus, timely action needs to be taken if the life of the ILS system is to be extended. In particular, the possible improvement alternatives need to be identified and investigated. One improvement to consider would be to require the user community to equip with 50 kHz channel receivers, possibly also adhering to the new ICAO immunity standards.

6.5.4 A new worldwide frequency allocation, in the DME and TACAN band, was obtained for the new GPS L5 civil signal at the 2000 World Radiocommunication Conference. To protect L5 operations, it was previously considered that it would be necessary to move a significant number of DME and TACAN frequency assignments. Such a system change would have been complicated by the need to also move many VOR frequency assignments, since most DME and TACAN operations are coupled with VOR operations from a frequency channel usage standpoint. However, in 2004, the results of a refined analysis by RTCA determined that it would be possible to lower the L5 signal acquisition threshold, thereby eliminating the need to move DME and TACAN frequency assignments to protect future L5 operations.

6.5.5 Other issues highlighted in this report include: (1) Loran C is being considered to be a part of a future navigation system mix, but does not operate in an ARNS band; (2) UWB devices, approved by the FCC, are allowed to transmit low power, wide band signals in spectrum below 960 MHz (including ARNS bands) and above 1.9 GHz, as FCC Part 15 devices; and (3) the transmission format of the new European satellite navigation system, Galileo, would interleave with the GPS signals in the 1559-1610 MHz band. Based on information to date, no insurmountable problems were foreseen in satisfying the known future frequency assignment requirements for the other navigation systems addressed in this report.

6.5.6 In the next year, new spectrum requirements for navigation systems to the year 2010 will be evaluated, and the navigation system spectrum management issues will be re-evaluated and modified as necessary, to reflect an up-to-date judgment of whether there will be sufficient spectrum availability to satisfy the navigation system requirements to the year 2010.

References for Section 6

6.1 "2001 Federal Radionavigation Plan", the official source of radionavigation policy and planning for the Federal Government, published jointly by the Departments of Defense and Transportation, DOT-VNTSC-RSPA-01-3/DOD-4650.5, March 2002.

6.2 "Spectrum Management Study to Determine the Feasibility of Protecting the New GPS Civil Signal L5 From RFI", by ATO-W ATC Spectrum Engineering Services, September 2003.

6.3 "Assessment of Radio Frequency Interference Relevant to the GNSS L5/E5A Frequency Band, DO-292, by RTCA, Incorporated (prepared by Special Committee (SC) 159), July 29, 2004.

Section 7 – Surveillance Requirements

7.1 Introduction

7.1.1 The surveillance capability forms a critical part of the communications, navigation, and surveillance triad that allows air traffic control to operate in a safe and efficient manner within the NAS. Typically, the pilot is issued an airspace clearance via A/G communications to fly a specific route and altitude profile. Surveillance provides the capability to verify the actual position of the aircraft within the NAS. This allows the air traffic controller to check on the progress of the aircraft to help ensure, inter alia, that the aircraft is following the clearance instructions and not deviating into a potentially dangerous situation. In addition, aircraft surveillance is becoming a more important function on the airport surface, since the increasing congestion at airports makes it necessary to know precisely where each aircraft is located. Thus, it is clear that the surveillance function plays a key role in the air traffic control function in the NAS. Various forms of radar support many of the aircraft surveillance functions. In addition, radars are utilized to gather data to help support the development of various weather products, including functions to reduce the potential impacts of severe weather in enroute and terminal airspace. Surveillance is an important function to civilian aviation, the DHS, and the DOD. NAS, DHS, and DOD systems overlap in the use of a number of frequency bands, and there is a significant degree of shared system use, which is made possible through close coordination and FAA management of the radar frequency bands used for ATC.

7.1.2 The need for better accuracy, capabilities for new applications, and an increased area of coverage has resulted in the implementation of a diverse and relatively large number of surveillance systems requiring a significant amount of radio frequency spectrum. There is continuing pressure for more and newer surveillance systems in many areas of the NAS. While ATO-W is doing its utmost to help satisfy the continued demand for surveillance services, without analysis it is not clear whether sufficient radio spectrum resources exist to satisfy all the new requirements. There is also increasing pressure from other services to use the spectrum used by surveillance systems. This surveillance system spectrum plan is a support element of the FAA's CIP, Flight Plan 2004-2009, and OEP.

7.2 Purpose

7.2.1 The purpose of this plan is to ensure, to the extent possible, that the future spectrum requirements for NAS surveillance system implementations to the year 2010 can be satisfied.

7.3 Background

7.3.1 Over the past half century, the implementation of a broad system of surveillance and weather radar installations has been carried out to satisfy enroute, terminal, and airport surface requirements. This implementation has required a significant amount of radio spectrum resources in a number of frequency bands across the spectrum. Factors relating to the amount of radio frequency spectrum needed include the number of systems to be implemented and the required frequency engineering criteria. The frequency engineering criteria are a complex set of parameters determining how close stations on the same channel or adjacent channels can be placed geographically, as well as preventing RFI from other systems. Further, phenomena such as ducting and troposcatter propagation need to be considered when engineering frequencies to support new radar systems. These factors result in an increase of the distance required between radar systems. Harmonics are another consideration that sometimes limit what frequencies can be used in a given location.

7.3.2 There are a number of ATC aircraft surveillance functions, including independent surveillance (primary radar), co-operative independent surveillance (SSR, also known as the ATC Radar Beacon System (ATCRBS)), and Automatic Dependent Surveillance (ADS, which is based on the automatic development and communication to the ground of position reports generated by onboard navigation systems). ADS-B, a form of ADS, is also being developed; this function provides for the periodic broadcast of position reports that may be taken advantage of by both ground systems and other aircraft. In many oceanic areas, voice position reports (dependent surveillance) provide the primary means for ATC to track aircraft, since this is often the only means of surveillance in these areas.

7.3.3 Unlike the communication and navigation systems, only SSR based functions (see Section 7.4 for the systems to be addressed) depend on aircraft equipment to cooperate with ground signals, or signals transmitted from other aircraft. Worldwide interoperability for SSR system functions is satisfied by requiring that system standards and frequency engineering criteria adhere to ICAO SARPs. SSR systems, and other surveillance and weather radar systems, must conform to U.S. regulations, including NTIA, FCC, and FAA regulations, technical standards, and service requirements, as appropriate. The development of radar systems is specifically subject to the application of NTIA Radar Spectrum Engineering Criteria (RSEC).

7.3.4 It is becoming increasingly difficult to satisfy the future requirements to implement additional facilities for existing aircraft surveillance and weather radar systems, and related new systems (see below) with the limited amount of available radio frequency spectrum. In addition, there is severe competition from other services and functions to use the limited amount of available spectrum (e.g., satellite navigation systems, UWB, and airborne synthetic aperture radars). The new systems include SSR-based ADS-B (other forms of ADS-B are addressed under the Navigation Section), airport multilateration systems, a new Airport Surface Detection Equipment (ASDE) called ASDE-X, new Airport Surveillance Radars (ASR...ASR-11s to replace ASR-7s and 8s),

a new SSR ATC Beacon Interrogator (ATCBI...ATCBI-6s to replace ATCBI 4s and 5s), and a new Monopulse SSR (MSSR...to be installed on ASR-11s). Further, spectrum management issues exist, as highlighted in the next section, that impact facility or system implementation. Thus, it is extremely important to closely manage the remaining spectrum resources.

7.4 Aircraft surveillance and weather radar spectrum management issues, future requirements, and the satisfaction of future requirements

7.4.1 Introduction

7.4.1.1 The spectrum management issues, future requirements, and the satisfaction of future requirements are presented, to the extent possible, on a frequency band basis, starting from the lowest frequency band used by aircraft surveillance and weather radar facilities. The study included the consideration of the following systems and system elements (the UAT and VDL-4 ADS-B systems, as well as a more detailed consideration of TLS, are covered in Section 6, Navigation Requirements):

1. ATCRBS/SSR (including Mode Select (Mode-S))
2. Multilateration Systems (including aircraft/vehicle identification for ASDE)
3. Traffic Alert and Collision Avoidance System (TCAS)
4. Precision Runway Monitor (PRM)
5. SSR Mode-S based ADS-B
6. Transponder Landing System (TLS)
7. Ramp Testers
8. Radar Beacon Performance Monitors (RBPMs) and Parrots
9. Air Route Surveillance Radar (ARSR)
10. Airport Surveillance Radar (ASR)
11. Next Generation (Weather) Radar (NEXRAD)
12. Terminal Doppler Weather Radar (TDWR)
13. Airport Surface Detection Equipment (ASDE)

7.4.1.2 There are also a number of airborne radar systems, not taken into account above, which are critical to ensuring the safety of flight. These include weather and altitude

measurement systems such as: radar altimeters and forward looking terrain avoidance radars operating within 4200-4400 MHz, airborne weather radars operating within 5350-5460 MHz and 9300-9500 MHz, and Doppler weather radars operating on 13.25-13.4 GHz. These are not FAA systems, and the FAA is not responsible for engineering or maintaining frequency assignments for these systems. However, due to the importance of these systems in ensuring safety of flight, the FAA works to ensure that adequate spectrum is available to satisfy airborne radar functional requirements; this includes ensuring protection of the frequency bands presently used by these systems.

7.4.1.3 Aircraft surveillance and weather radar service requirements to the year 2010 are still evolving. Those requirements that are known to date will be highlighted in this section. A consideration of whether these known requirements can be satisfied is based on the results of frequency engineering carried out to date. Future requirements will be examined from a system standpoint, rather than from whether the requirement is a specific enroute, terminal, surface coverage, or weather service requirement.

7.4.2 1030/1090 MHz band

7.4.2.1 Frequency congestion: There are a relatively large number of present and new surveillance functions to be satisfied on the frequencies 1030 MHz and 1090 MHz (each frequency is the center frequency of a bandwidth of up to 21.5 MHz). Specifically, the systems and functions identified in Items 1-6 in Section 7.4.1.1 above operate on these frequencies. 1030 MHz is the frequency used by ground SSR facilities to interrogate aircraft transponders. Aircraft, upon receiving an interrogation on 1030 MHz, respond on 1090 MHz. In addition to the frequency pair 1030/1090 MHz being used for such SSR functions as ATCRBS and Mode-S, these frequencies are also used for TCAS, PRM, TLS, a type of ADS-B and its elements, and multilateration functions. RBPMs that transmit on 1090 MHz are also associated with most SSR facilities. There are approximately 1741 frequency assignments on these frequencies, of which 976 are FAA and the remainder is DOD. To keep these systems from interfering with each other, such measures as different pulse repetition rates (PRRs) and limiting the transmit power of the interrogator based on the surveillance range (including the TCAS power management algorithms) are utilized. Channel occupancy is the principal problem on the 1030/1090 MHz frequencies. An aircraft is limited in the number of interrogations it can process before saturation occurs, after which it can no longer reply effectively. Furthermore, a ground facility can also only receive so many responses on 1090 MHz before it too becomes saturated and can no longer track all of the responses.

7.4.2.1.1 Two actions that are underway to relieve congestion on 1030/1090 MHz are the implementation of Mode-S and Monopulse SSR systems. Both of these systems require fewer interrogations (by using an addressing scheme to select the particular aircraft to interrogate). This results in a reduction in transponder occupancy time, thus allowing the aircraft to be able to respond to a larger number of interrogators. Consequently, there are not as many responses on 1090 MHz that the ground facilities need to process. Thus,

these system improvements achieve an enhanced level of spectrum utilization efficiency over the traditional ATCRBS.

7.4.2.2 SSR Mode-S site identification codes: Presently, aircraft only have 16 SSR Mode-S ground site identification (ID) codes, while the ground system can have 64 ID codes. In some geographic areas a large number of SSR Mode-S ground sites can be in communication with an aircraft, making the 16 ID codes on the aircraft insufficient to ensure a unique identification of the ground sites. Two new ID address bits have been added through standardization action by ICAO to increase the aircraft ID codes to 64; however, it will take some years for a full aircraft implementation of this new capability. In the meantime, several actions are being taken to help alleviate this situation, as highlighted below. The complexity of this issue is increased by the need to ensure compatibility with Canadian systems operating close enough geographically with NAS system elements to be impacted by constraints imposed by the frequency assignment criteria. The anticipated DOD conversion to Mode-S will only exacerbate the existing shortage of Mode-S site ID codes.

7.4.2.2.1 In particular, two actions are being taken to help alleviate the Mode-S aircraft ID issue during the near term. The ATC Beacon Interrogator 6 (ATCBI-6) program contract has been modified to allow sector ID codes to be related to a sector of the airspace. In addition, two separate “frame tables” for each Mode-S ID code are being created, with the ID codes being associated with a specific pulse repetition frequency (PRF). Even with these actions, however, there may be geographic areas where there are not enough Mode-S site IDs to prevent interference between systems. Meetings are currently being held among the FAA William J. Hughes Technical Center, ATO-W Spectrum Engineering Services, the various FAA program offices with an interest in Mode-S, and Canada to devise a solution to this potential future crisis. Solutions being examined include "mosaicing" radar systems together so that Mode-S site ID codes can be shared or initiating action to permit the use of the full set of 64 site ID codes that are potentially available. All potential solutions require substantial funding, however, which is another obstacle in today's austere funding environment.

7.4.2.3 DOD use of 1030/1090 MHz: The DOD use of SSR Mode 4 impacts the operational capability of NAS SSR functions by limiting the civil transponder capability to reply to ATC interrogations from the ground system. As a consequence, the DOD is upgrading to an SSR Mode 5 operational mode that will significantly reduce the impact to civil transponder operations. However, Mode 5 will not be fully operational until the year 2015. But, to help expedite the transition to Mode 5, the DOD has issued a directive that requires all future transponder replacements to be Mode 5 capable. In the meantime, a memorandum of understanding between the FAA and DOD has been developed to establish coordination procedures to reduce the impact of Mode 4 operations to the NAS.

7.4.2.4 Future 1030/1090 MHz requirements and spectrum availability: The FAA Runway Incursion Reduction and the Safe Flight 21 Programs have introduced several new technologies that use 1030/1090 MHz. The use of multilateration in conjunction with the ASDE-3 and ASDE-X programs to provide aircraft identification for surface

surveillance will have the biggest impact on the capacity of the 1030/1090 MHz frequency pair. Multilateration has the potential to be implemented at 79 airports initially, and possibly many more airports will be identified to receive this capability in future years. To further improve surface surveillance, experimentation using 1030/1090 MHz to track vehicles operating on the runway movement area is being conducted. If this function proves beneficial, such a vehicle tracking capability could be added at airports equipped for multilateration. Studies have been initiated to determine the feasibility of expanding the vehicle tracking capability to the "airplane side of the airport" (e.g., ramp areas and de-icing stations). ADS-B is an additional 1030/1090 MHz function being implemented for use by the civil aviation community. The Volpe National Transportation Systems Center was contracted by the FAA to conduct studies to ensure that 1030/1090 MHz would have the capacity to accommodate these additional functions without negatively affecting the performance of existing functions. These studies assumed the implementation of ongoing system improvements and a forecast of future traffic. The impact of adding multilateration, including ground vehicle tracking, and ADS-B was an approximate 3% reduction in current ATCRBS "round-reliability" performance. ATO-E and ATO-T chose to accept this negligible degradation so that the benefits of the new system functions can be realized. Area multilateration is being tested in Memphis, Tennessee; the Gulf of Mexico; and at the Patauxent Naval Air Station. In addition, it is planned that a small number of PRM and TLS systems will be implemented.

7.4.3 1215-1390 MHz band

7.4.3.1 Frequency congestion: Most ARSR systems (primary radars) operate in the 1240-1370 MHz portion of the 1215-1390 MHz band (which is allocated to the ARNS) to support the NAS enroute aircraft surveillance function (some joint use FAA/DOD radars supporting the NAS operate across the entire 1215-1390 MHz band). This service is provided in addition to the secondary radar service provided by SSR systems operating on 1030/1090 MHz (which provides, in addition to position, aircraft identification, aircraft altitude via an ADS data link function (Mode C), and A/G data link communications). There are a total of 127 ARSR systems operated by the FAA in support of the NAS, plus an additional four that are used for training. Each ARSR requires two channels to operate (for frequency diversity), with each channel requiring up to 10 MHz bandwidth (measured at -20dB points). Frequency assignment congestion is a primary issue, stemming from a loss of spectrum and pressures to accommodate the operation of other systems in the 1215-1390 MHz band. This and other issues concerning present and future operations are highlighted in the following paragraphs.

7.4.3.2 Loss of 1390-1400 MHz: As a part of the Omnibus Budget Reconciliation Act of 1993 (OBRA-93, which sought to transfer 200 MHz from Government frequency allocations, to be used for future commercial radio frequency devices), the 1390-1400 MHz portion of the band was lost for radar system usage. The FAA has completed modifications to FAA enroute radar systems to deal with the impacts of this loss of spectrum. It required the installation of costly filters on NAS ARSR systems: transmit

filters on ARSR-1 and 2 systems, and receive filters on ARSR-4 systems. On the positive side, the filters helped resolve a long standing ARSR-4 interference issue from UHF TV stations, and on the ARSR-1s and 2s, the new “absorptive” filters helped eliminate previous problems caused by “reflective” filters. It is too early to know the possible impacts of new commercial radio frequency devices in 1390-1400 MHz; however, ATO-W is coordinating with other Government agencies on this issue and must remain alert to ensure protection of ARSR services.

7.4.3.3 Sharing with the Radionavigation Satellite Service (RNSS): The new frequency allocation to allow RNSS, as a co-primary service, in the band segment 1215-1300 MHz will add additional sharing pressures on the operation of ARSR systems. The GPS L2 signal is at a center frequency of 1227.6 MHz, with a bandwidth of approximately 20 MHz, which is outside the operating frequency ranges of most ARSR systems. However, GLONASS has a signal centered at approximately 1250 MHz, and the new European Galileo satellite navigation system design is proposing to operate in the vicinity of 1260-1300 MHz (within the new RNSS allocation); such operations would be within the operating frequency ranges of most ARSR systems. The additional signals from Galileo may be a problem for, in particular, the ARSR-4 systems, since they have more sensitive receiver systems (to allow operation with less transmit power than other ARSR systems). The FAA is participating in studies and several international forums to address this issue. Action will be taken, as may be necessary, to eliminate any potential for interference to ARSR systems (this may include the need to develop and adopt additional mitigation techniques as a last resort).

7.4.3.4 Sharing with DOD communications systems: DOD mobile point-to-point communications systems operate in the frequency band segment 1350-1390 MHz on a co-primary basis. In addition, the DOD operates some A/G data link communications in this band segment to support the tracking of aircraft on military ranges. DOD fixed, mobile, and airborne operations are being relocated from the 1390-1400 MHz and 1427-1435 MHz bands into the 1350-1390 MHz band. Such communications have the potential to interfere with and pose operational constraints to ARSR system operations. On going coordination is required to ensure that unacceptable NAS service restrictions are not imposed by DOD operations.

7.4.3.5 Amateur radio service operations: Amateur radio service operations are allowed in the 1290-1300 MHz band segment on a secondary (radio frequency spectrum allocation) basis. This allocation basis gives regulatory protection to ARSR operations from amateur radio service operations. Ongoing coordination and analysis is necessary to ensure continued interference-free service.

7.4.3.6 Review of the NTIA radar engineering criteria: An on-going review of the NTIA RSEC is being conducted within Working Group 1 (WG-1) of the Technical Subcommittee, of the Interdepartment Radio Advisory Committee. The aim of WG-1 is to tighten the design criteria and thereby help relieve frequency assignment congestion. While supporting this effort, ATO-W must continue to ensure that any revisions to the criteria do not unduly restrict the design and future operations of ARSR systems.

7.4.3.7 The future of ARSR as a service: It is considered that primary radar services will be needed to support enroute and terminal surveillance functions for the foreseeable future. Primary radar has the benefit of providing surveillance information on “non-cooperative” airspace users; that is, aircraft that don’t have SSR transponders, have SSR transponders that have failed, etc. The FAA will continue to address the future role of primary radar services in support of NAS enroute airspace operations in dialogues with the DOD. It is anticipated that any change in the present ARSR system would be taken on a systematic and evolutionary basis.

7.4.3.8 Future ARSR requirements and spectrum availability: At the present time no future requirements are predicted for additional ARSR systems for the NAS. The FAA is conducting compatibility testing, and taking action, as necessary, to determine the potential of any inband RNSS to cause interference, as highlighted in Section 7.4.3.3 above. In particular, the FAA will need to focus on the new European Galileo satellite navigation system to ensure that, if implemented, it does not cause radio frequency interference to ARSR systems (in particular ARSR-4 systems).

7.4.4 2700-3000 MHz band

7.4.4.1 Frequency congestion: The primary issue with this band is frequency congestion. Both ASR and NEXRAD operations are in this band. The FAA operates 277 ASRs in this band and there are also DOD, NASA, and non-federal ASRs. In addition, the FAA, U.S. Air Force, and the National Oceanic and Atmospheric Administration operate 206 NEXRADs in this band, which provide weather support for the NAS. Each ASR (ASR-7s, 8s, 9s, and 11s) requires two channels to operate (for frequency diversity), with each channel requiring up to 10 MHz bandwidth (measured at –20dB points). The new ASR-11s that are being implemented to replace ASR-7s and 8s require a narrower bandwidth per channel (5.6 MHz at –20dB); however, during the 4 to 6 month implementation transition period, both the old radar (an ASR-7 or 8) and the new ASR-11 are required to operate simultaneously.

7.4.4.2 Possible impact of revised NTIA system design criteria: The most stringent RSEC requirements are applicable to radars operating in this band. ATO-W is working within the NTIA process to help ensure that any future revisions to the RSEC will have the least possible impact on present and future NAS operations within the 2700-3000 MHz band. Recently, several DOD tactical systems have been developed for operation in this band that do not satisfy the design criteria. The FAA is working with DOD to ensure that these systems will be retrofitted to bring them into compliance.

7.4.4.3 Future ASR and NEXRAD requirements and spectrum availability: Future requirements for additional ASR and NEXRAD radars for the NAS are under study.

7.4.5 5600-5650 MHz band

7.4.5.1 Implementation of private sector weather radars: A total of 48 NAS TDWRs operate in this band. The most significant problem is that commercial TV stations desire to implement their own weather radars in this band. In addition to proposing placement of these radars in or near major cities, where TDWRs already operate, these radars have much less stringent specifications than NAS systems. This results in a significant workload in reviewing proposed system implementations and in communicating with industry regarding why their radars cannot be implemented at the requested location and with the proposed specifications.

7.4.5.2 Future TDWR requirements and spectrum availability: Future requirements for additional TDWR radars for the NAS are under study.

7.4.6 9-9.2 GHz band

7.4.6.1 ASDE-X compatibility: ASDE-X ground surveillance radars are planned to be implemented in this band. The primary issue is ensuring compatibility with existing DOD precision approach radars (PARs). (It should be noted that the current ASDE-X and the newer PARs use four frequencies to provide their services.) Study was conducted resulting in a conclusion that this was essentially a “non-issue” under the current deployment plan to implement ASDE-Xs at 39 airports. If additional ASDE-Xs are implemented, compatibility with PARs might be a far more serious issue. The ASDE-X program has also developed a new surface movement radar (SMR) that operates on 16 randomly selected frequencies within the 9.0-9.2 GHz band, to attempt to alleviate performance issues with the current ASDE-X SMR. Studies are currently underway to analyze the compatibility of this new ASDE-X SMR capability with PAR system operations.

7.4.6.2 ASDE-X requirements and spectrum availability: It is planned to implement 39 ASDE-X systems within the NAS by CY-2007. Future requirements for additional ASDE-X systems are under study.

7.4.7 15.7-16.2 GHz band

7.4.7.1 ASDE-3 implementation: Presently there are 40 NAS ASDE-3 systems. At this relatively high frequency there is a large signal attenuation due to rain and problems with multipath. This limits the functional capability of the ASDE-3 system. As a result, no future requirements are predicted for ASDE-3 systems.

7.5 Summary and conclusions

7.5.1 The ATC surveillance function is a critical element in supporting a safe and efficient NAS. Over the years the need for improved ATC surveillance capabilities has resulted in the implementation of a diverse and relatively large number of surveillance systems requiring a significant amount of radio frequency spectrum (see Section 7.4.1). This section has highlighted and addressed ATC surveillance and weather radar systems, including a consideration of the satisfaction of future spectrum requirements to support these system capabilities until the year 2010. This surveillance system spectrum plan is a support element of the FAA's CIP, Flight Plan 2004-2009, and OEP.

7.5.2 One area of concern addressed in this section is the multitude of systems operating in, and new functions planned to operate in, the 1030/1090 MHz band segments. Actions are being taken, including the implementation of Mode-S and Monopulse SSR systems, to help alleviate the present high degree of channel occupancy in this band. A shortage of Mode-S Site ID codes is a problem area being addressed (see Section 7.4.2.2). Another area of concern is that the DOD use of SSR Mode 4 impacts the operational capability of NAS SSR functions (see Section 7.4.2.3); a new DOD Mode 5 capability to alleviate this problem area will not be fully operational until 2015. Increased usage of 1030/1090 MHz also stems from the FAA Runway Incursion Reduction and Safe Flight 21 Programs, which have introduced several new technologies.

7.5.3 Frequency congestion is an issue in the 1215-1390 MHz band, and the FAA has already dealt with the impacts of the loss of 1390-1400 MHz as a part of OBRA-93 (see Section 7.4.3.2). In addition, the FAA must remain alert to the possible impacts of the use of new commercial radio frequency devices in 1390-1400 MHz. There are also concerns with spectrum sharing with the new RNSS frequency allocation in the band segment 1215-1300 MHz; in particular, there is the potential for radio frequency interference to some ARSR systems from the planned new European Galileo satellite navigation system (see Section 7.4.3.3).

7.5.4 Some spectrum usage problems persist in other bands, including the 2700-3000 MHz band used for ASR and NEXRAD operations, the 5600-5650 MHz band used for TDWR operations, the 9-9.2 GHz band used for ASDE operations, and the 15.7-16.2 GHz band also used for ASDE operations. In particular, the implementation of private sector weather radar systems in the 5600-5650 MHz band, used by commercial TV stations, results in a significant FAA workload (see Section 7.4.5.1).

7.5.5 In summary, while a significant degree of frequency congestion and some problem areas exist in the frequency bands supporting the surveillance systems addressed in this section, it is concluded that the future spectrum requirements for these systems can be satisfied until 2010.

Glossary of Acronyms

ADS	Automatic Dependent Surveillance
ADS-B	ADS-Broadcast
AFM	Automated Frequency Manager
AFS	Flight Standards Service, AFS-1
AFSS	Automated Flight Service Stations
AFTRCC	Aerospace Flight Test Radio Coordinating Council
A/G	Air-Ground
ACP	ICAO Aeronautical Communications Panel
AM(R)S	Aeronautical Mobile (Route) Service
AMS(R)S	Aeronautical Mobile Satellite (Route) Service
ANLE	Airport Network and Location Equipment
AOC	Aeronautical Operational Control
AOPA	Aircraft Owners and Pilots Association
ARAC	Aviation Rulemaking Advisory Committee
ARINC	Aeronautical Radio, Incorporated
ARNS	Aeronautical Radionavigation Service
ARSR	Air Route Surveillance Radar
ARTCC	Air Route Traffic Control Center
ASDE	Airport Surface Detection Equipment
ASOS	Automated Surface Observation System
ASR	Airport Surveillance Radar
ATC	Air Traffic Control
ATCBI	ATC Beacon Interrogator
ATCRBS	ATC Radar Beacon System
ATIS	Automated Terminal Information Service
ATO-D	FAA Air Traffic Organization Flight Services
ATO-E	FAA Air Traffic Organization Enroute and Oceanic Services
ATO-R	FAA Air Traffic Organization System Operations Services
ATO-T	FAA Air Traffic Organization Terminal Services
ATO-W	FAA Air Traffic Organization Technical Operations Services
ATS	Air Traffic Service
AWOS	Automated Weather Observation System
CAP	Civil Air Patrol
CAST	Civil Aviation Safety Team
CIP	Capital Investment Plan
CNS	Communications, Navigation, and Surveillance
COM/OPS-1995	1995 ICAO Communications/Operations Divisional Meeting
COM/MET/OPS-1990	1990 ICAO Communications/Meteorology/Operations Divisional Meeting
CONUS	Continental United States
COSPAS/SARSAT	Russian/U.S. Search and Rescue Satellite Aided Tracking Systems
CPDLC	Controller-Pilot Data Link Communications
CY	Calendar Year
DF	Direction Finder
DO	RTCA Document
DHS	Department of Homeland Security
DOD	Department of Defense
DOJ	Department of Justice
DME	Distance Measuring Equipment
DSB-AM	Double Sideband-Amplitude Modulation
DRVSM	Domestic Reduced Vertical Separation Minima
ELT	Emergency Locator Transmitter

Glossary of Acronyms - continued

ESV	Expanded Service Volume
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
FBMLS	Fixed Base Microwave Landing System
FISDL	Flight Information Service-Data Link
FM	Frequency Modulation
FMO	FAA Frequency Management Officers
FPSV	Frequency Protected Service Volume
FRP	Federal Radionavigation Plan
FSS	Flight Service Station
FY	Fiscal Year
GC	Ground Control
GLONASS	Russian Satellite Navigation System
GMF	Government Master File
GPS	Global Positioning System
HIWAS	Hazardous In-flight Weather Advisory Service
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
ID	Identification
ILS	Instrument Landing System
INS	Inertial Navigation System
IOC	Initial Operational Capability
ITU	International Telecommunications Union
JTIDS/MIDS	Joint Tactical Information Distribution System/Multifunctional Information Distribution System
LAAS	Local Area Augmentation System
L1	GPS Civil Navigation Signal
L2	GPS DOD Signal
L5	GPS Civil Navigation Signal (Planned)
MLS	Microwave Landing System
MMLS	Mobile MLS
Mode S	SSR Mode Select
MOU	Memorandum of Understanding
MSSR	Monopulse SSR
NAR	National Airspace Redesign
NARC	NEXCOM Aviation Rulemaking Committee
NAS	National Airspace System
NDB	Non-Directional Beacon
NEXCOM	Next Generation VHF Air-Ground Communications System
NEXRAD	Next Generation Weather Radar
NIFC	National Interagency Fire Center
NM	Nautical Mile
NTIA	National Telecommunications and Information Administration
OBRA-93	Omnibus Budget Reconciliation Act of 1993
OEP	Operational Evolution Plan
PAR	Precision Approach Radar
PBFA	DOD Policy Board on Federal Aviation
PRF	Pulse Repetition Frequency
PRM	Precision Runway Monitor
PRN	Pseudo Random Noise
PRR	Pulse Repetition Rate
RBPM	Radar Beacon Performance Monitors
RCAG	Remote Control Air-Ground Sites
RFI	Radio Frequency Interference
RNAV	Random Air Navigation
RNSS	Radionavigation Satellite Service

Glossary of Acronyms - continued

RSEC	NTIA Radar Spectrum Engineering Criteria
RTCA	RTCA, Incorporated
RVSM	Reduced Vertical Separation Minimum
SARPs	ICAO Standards and Recommended Practices
SC-172	RTCA Special Committee 172
SCAT-1	Special Category One System
SID	Standard Instrument Departure
SMR	Surface Movement Radar
SSR	Secondary Surveillance Radar
STAR	Standard Arrival
TACAN	Tactical Air Navigation System
TCAS	Traffic Alert and Collision Avoidance System
TDMA	Time Division Multiple Access
TDWR	Terminal Doppler Weather Radar
TLS	Transponder Landing System
TSV	Tailored Service Volume
UAT	Universal Access Transceiver
UHF	Ultra High Frequency
UNICOM	Aeronautical Advisory Station
U.S.	United States
UWB	Ultra Wideband
VDL	VHF Digital Link
VDL-2	VDL Mode 2
VDL-3	VDL Mode 3
VDL-4	VDL Mode 4
VHF	Very High Frequency
VOR	VHF Omnidirectional Range
VOT	VOR Test Facility
VSCS	Voice Switching and Control System
WAAS	Wide Area Augmentation System
WG-1	Working Group 1 (of the Technical Subcommittee of the NTIA Interdepartment Radio Advisory Committee)

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FAA Organization Reference Glossary

The names of the FAA Organizations below (first line in each entrance), which were referenced in the 2003 edition of the Radio Spectrum Plan, have changed (as a result of re-organization). The second line in each entrance presents the organizational reference for the 2004 plan.

ACB	FAA William J. Hughes Technical Center, ACB-1 FAA William J. Hughes Technical Center
AF ATO-W	FAA Airway Facilities Service, AAF-1 FAA Air Traffic Organization Technical Operations Services
AGL	FAA Great Lakes Region, AGL-1 FAA Central Service Area (which includes the Great Lakes Region, as well as the Central and Southwest FAA Regions)
AND	FAA Office of Communications, Navigation, and Surveillance Systems, AND-1 ATO-W ATC Communications Services or ATO-W Navigation Services, referenced as appropriate
ANI	FAA National Airspace System Implementation Program, ANI-1 ATO-W ATC Facilities
ANM	Northwest Mountain Region, ANM-1 FAA Western Service Area (which includes the Northwest Mountain Region, as well as the Western Pacific and Alaskan FAA Regions)
ASR	FAA Spectrum Policy and Management, ASR-1 ATO-W ATC Spectrum Engineering Services
ARS-20	Aerospace Weather Policy and Standards Staff FAA Air Traffic Organization System Operations Services (ATO-R) System Operations Program
AT ATO-E ATO-T	FAA Air Traffic Service, ATS-1 FAA Air Traffic Organization Enroute and Oceanic Services FAA Air Traffic Organization Terminal Services
ATP-300	Flight Services Operations Division FAA Air Traffic Organization Flight Services (ATO-D) Flight Services Safety and Operations Support
AVN	FAA Aviation System Standards Program, AVN-1 ATO-D Aviation System Standards